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ANALYSIS OF A SPACE PHOTO OF A HUMID AND FORESTED REGION: A CASE STUDY OF THE TENNESSEE VALLEY

by

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Introduction

Traditional sources of data for regional investigations have included library materials, air photos, interviews and field mapping techniques. Each of these data sources has several inherent disadvantages which are related to temporal and spatial aspects of geographic research. Census materials, for example, are often biased in terms of their purposes of construction, and thus frequently Census categories are of little value for other investigative purposes. On occasions, Census statistical units--counties or even minor civil divisions--are too large to accurately describe detailed spatial data. In addition, geographical landscape realities frequently do not coincide with assigned political boundaries; phenomena may arrange themselves spatially in many manners within census areas.

Field observations are confined to local terrestrial scenes, and in many respects a field worker is controlled by a type of geographical "Heisenberg principle," that is, if one is interested in the details of a situation affecting a local scene, it is impossible to get an overall view of how the local situation relates to regional, sectional, and global situations. Air photos provide primary geographical data and information that tend toward the larger formats of geographical concern. But conventional air photos, that is the standard USDA-SCS, 1/20,000 photos, focus on phenomena that are but a little smaller in scale than that which geographical field investigators are familiar. It is the different perspective of spatial relations of terrestrial features which air photos provide in relation to field observations--view from above rather than from the

horizontal--which is more significant for geographical data-acquisition purposes than is the change in scale; the concept of Landschaftsbild.[1] Maps of various scales can provide information at smaller, and thus more generalized, scales. But maps are secondary sources of spatial data. Original data for their construction, generally, must pass through a number of "filtering" processes, similar to the process of assembling census data. To some degree, recent technological advances and events should provide a means whereby the inadequacies associated with the heretofore mentioned conventional sources of geographical data can be overcome. Specifically, references here are being made to data from orbiting spacecraft.

In recent times, several investigators have reported their findings, thoughts and conclusions concerning the uses of orbital imagery for scientifi research.[2] These investigations have been conducted, to a large extent, in arid or semi-arid regions. Research on such regions has been deliberate; these regions are cloud-free and enjoy the cleanest atmosphere of all the inhabited land surface areas of the earth. While it is true that for certain types of physical terrestrial phenomena, particularly geologic characteristics, the desert or steppe-type environments provide excellent field laboratories, the more important aspects of cultural phenomena, however, including man himself, are associated with the more humid zones of the earth. Thus, the particular attention of this report is toward the use of orbital imagery of a humid-forested region--the Tennessee Valley of northern Alabama and adjacent areas.

[1] Richard Hartshorne, Perspective on the Nature of Geography (Chicago, Illinois: Rand McNally & Company, 1959), p. 23.

[2] J. Brian Bird and A. Morrison, "Space Photography and Its Geographical Applications," The Geographical Review, Vol. LIV, No. 4 (October, 1964).

Specifically, the following report is divided into two parts. The first is concerned with identifying various types of objects of some spatial significance to the area that are detectable from the space photograph. Although this type of approach is a necessary first step in the process of interpreting imagery of any scale, it does not represent anything more than a pedestrian approach, especially from a methodological standpoint. The second part, however, is concerned with observing, interpreting, and analyzing from the space imagery areal data in the form of regional patterns. It is proposed herein that an orbital position provides a unique vantage point for delimiting regional patterns of large areal extent. Furthermore, it is proposed that these patterns, called photomorphic units, are in reality meaningful functional units, and they serve to provide a means whereby the decision-making with respect to resource development and physical planning of regions can be carried forth in an optimum and effective manner.

Introductory Description of Photograph and Area.--The photograph chosen for this study is a low oblique Ektachrome photo of a humid landscape centered on northwestern Alabama with adjacent portions of northeastern Mississippi and south central Tennessee shown (See Figures 1 and 2). The center of the photograph is approximately 34° 40' North latitude and 87° 55' West longitude. The approximate coordinates of the photo corners are as follows: northwest corner, 36° 15' North, 88° 50' West; northeast corner, 35° 25' North, 86° 50' West; southeast corner, 33° 50' North, 87° 20' West; and southwest corner, 34° 05' North, 88° 45' West.

The low oblique photograph used in this study was produced from a 70 millimeter negative (film SO 121), and was taken from an altitude of 143 miles with a handheld Hasselblad 500-C camera with an 80 millimeter lens (modified by NASA). It was taken on the Earth orbital mission of Apollo 9 on March 11, 1969 at 1030 hours, Central Standard Time. Two Ektachrome

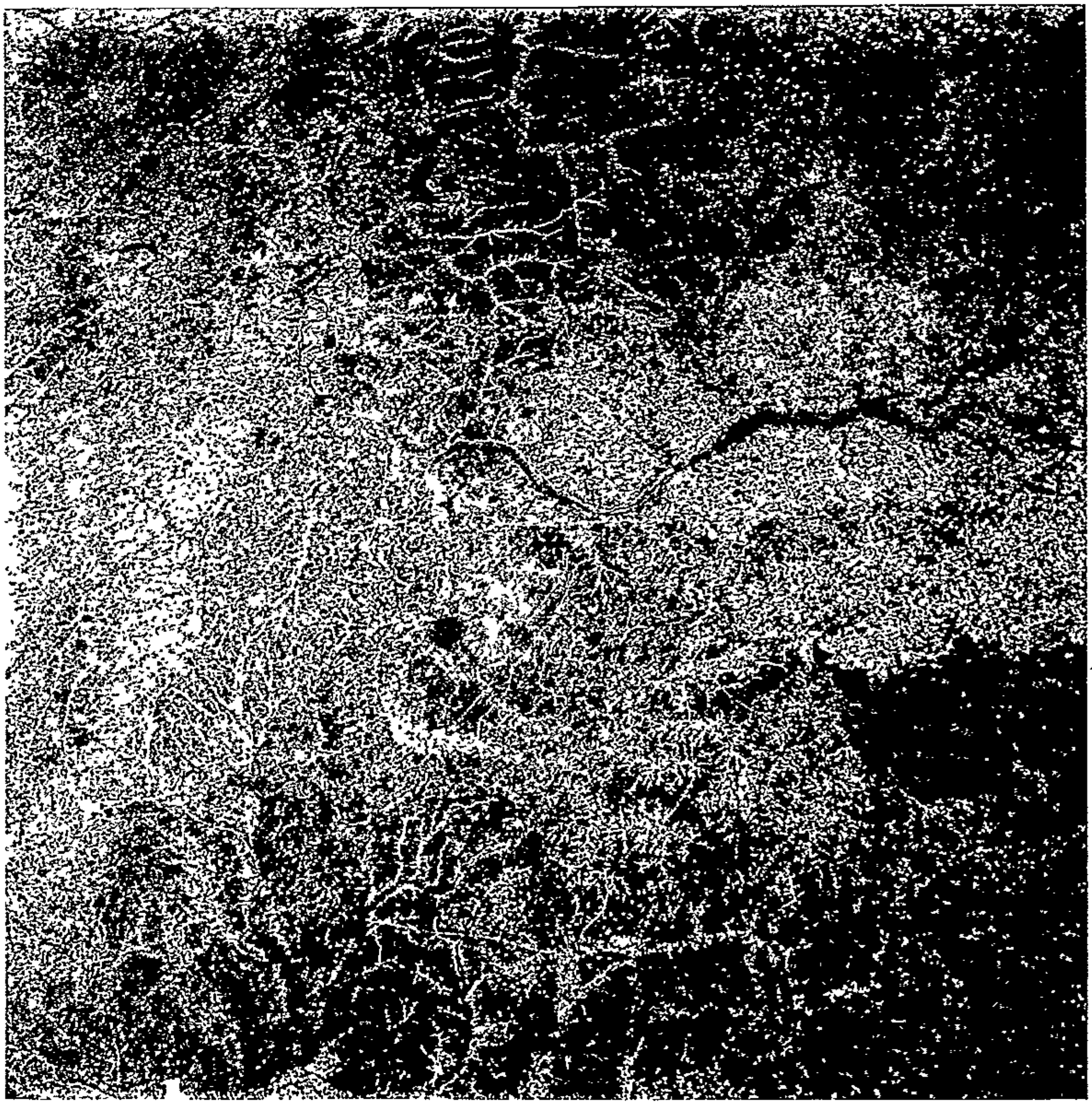


Figure 1

Black and white reproduction of Ektachrome positive of Northwestern Alabama and adjacent areas. The photograph was taken from an altitude of 143 nautical miles on the earth orbital mission of Apollo 9 on March 11, 1969 and covers an area between 10,000 and 12,000 square miles.

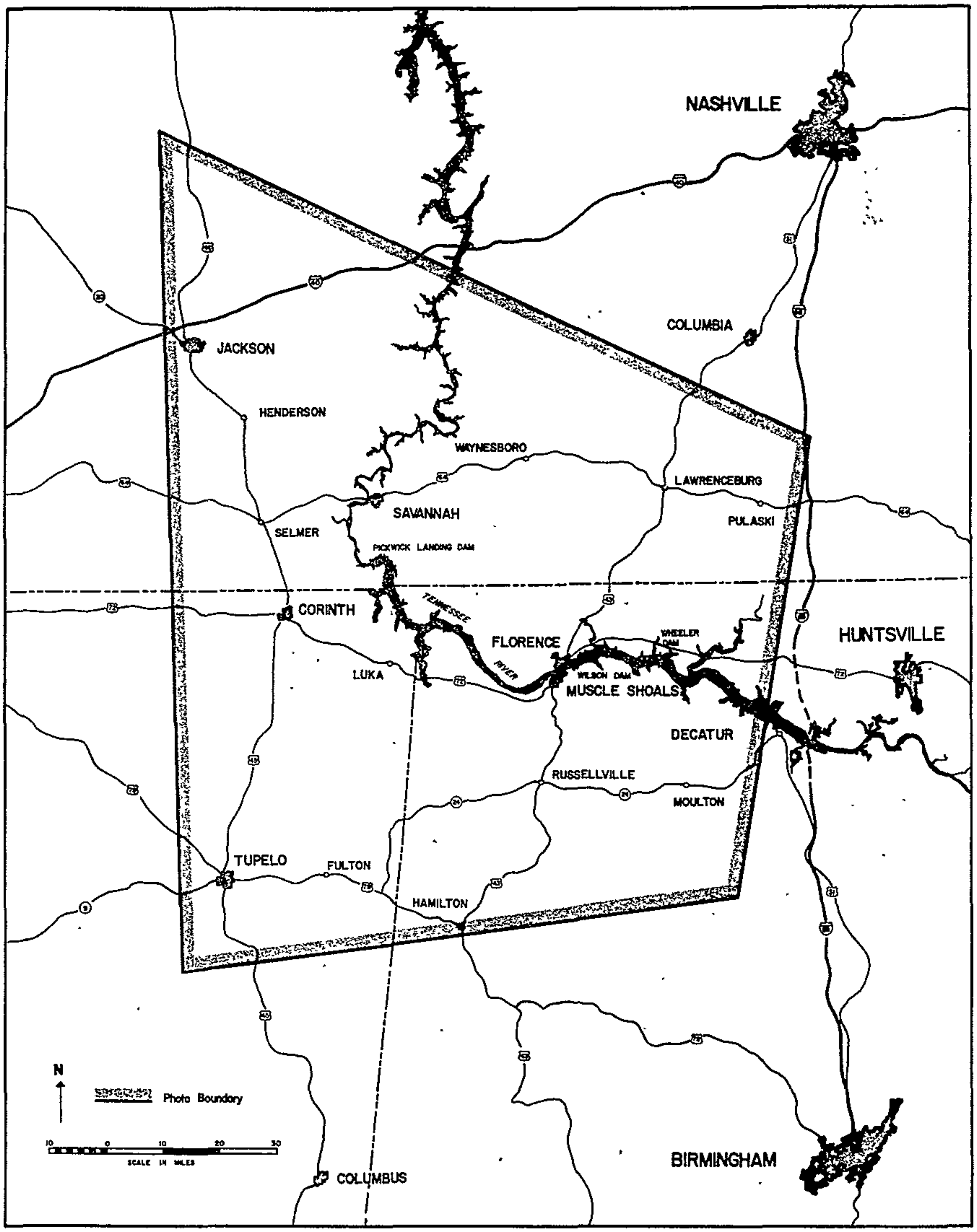


Figure 2
Photograph coverage area of Apollo 9, Magazine D, Frame Number 94, AS9-23-3565.

enlargements (10" x 10½" and 20" x 20") were used in this study. The scale along 34° 30' North parallel of the 10" x 10½" photograph was approximately 1:570,000.

Analysis of the photo was accomplished with the aid of 2½ power stand-magnifiers. Sample resolution determination revealed that distinct non-linear targets with side dimensions of less than 500 feet could not be identified in any portion of the photograph. However, linear features, e.g. highways and pipeline clearings 100 feet in width, could be identified in the central portion of the photograph. Target size and contrasting land use traits (based on photographic color and texture) proved to be very significant in signature identification.

The area most clearly shown on the photograph lies adjacent and to the south of the Tennessee River embayments east of Pickwick Dam on the Tennessee River. The urban complex of Florence-Muscle Shoals-Sheffield-Tuscumbia, Alabama, is located in the northcentral portion of this higher resolution portion of the photograph. Due to the obliqueness and varying scale throughout the photograph, the area depicted in the photograph varies greatly in its level of recognition and/or interpretation. The most revealing portion of the photograph is situated near the central portion and southeast quadrant. Because the peripheral regions in the northwest and northeast corners of the photograph are of less value for interpretation than the east-central portion, the investigative efforts were devoted largely to the counties of Colbert, Franklin, Lauderdale, and Lawrence in northwestern Alabama (See Figure 3). The major land use categories identifiable in this four-county area are urban places, agricultural land, forest and woodland, strip mining operations, and surface water features.

Atmospheric Condition.--Conditions of the atmosphere, both before and during the photographic mission, are important in determining the signatures

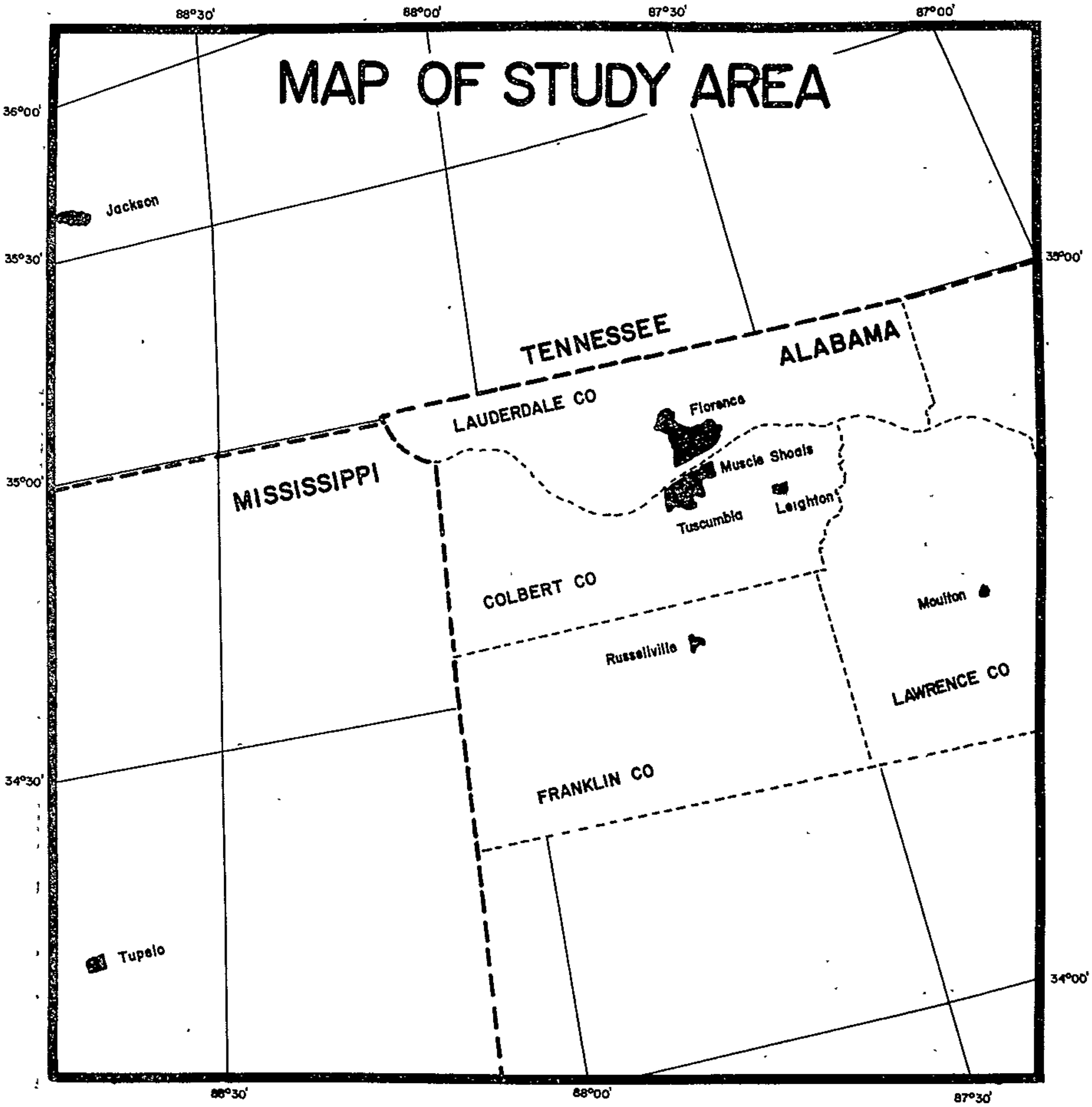


Figure 3

Map of Study Area. Four counties (Colbert, Lauderdale, Lawrence and Franklin) of northwestern Alabama were selected for photomorphic land use study.

recorded on the photographic image. The day the photograph was taken, the weather of the southeastern portion of the United States was dominated by a large anticyclone centered on the Texas-Oklahoma border which was responsible for producing clear and cold conditions over the study area. During the early morning hours a temperature inversion had developed over much of the area above the 700 foot level, but this had probably dissipated by the time the photograph was taken.[3] The sky was generally clear with an unlimited ceiling, and scattered patches of stratocumulus were developed over some of the area. These clouds observed on the photograph were probably due to a weak upper-air cyclonic flow and a temperature inversion producing a cloud base at about 850 millibar level. In general, the atmosphere was clear and conditions were excellent for orbital level photography.

Specific Target Interpretation

This section is devoted to a description of the analysis of selected features of the Apollo photograph; these features include water bodies, forests, lithology and physiography, settlements, and transportation features. It is not a detailed analysis of different types of signatures, but a brief demonstration of (1) the type of geographic data which can be extracted from a photograph of the Apollo 9 type and (2) the rationale for the interpretation of the specific selected features in relation to Census units and photomorphic units mentioned in later sections of this report.

Interpretation Procedures and Signature Identification.--An obvious conclusion after giving the Apollo photographs only a cursory glance is that one can differentiate, rather quickly and easily, large water bodies (rivers and reservoirs) and areas covered by forest from other features. In general,

[3]U.S.Weather Bureau Records for Alabama (Asheville, North Carolina: Asheville Weather Records Bureau, March, 1969).

the water bodies and the forested areas are more uniform in their color (hues, chroma, and saturation) and textural characteristics than are the signatures which represent non-forest and non-water body objects. However, none of the signatures are absolute, i.e. each signature-cell varies from what could be thought of as a model signature for an object. Among other factors responsible for these variances are the angle of the camera with respect to object photographed and the different interacting reflective characteristics of light with the object. The latter is caused by differences of reflective materials within the objects being imaged which results in variations of signatures for the same general object.

Included within the non-forest and non-water signature identification categories are soils, lithology, field patterns, urban areas, crop types, settlements (included urban areas), woodlots, and transport routes. This is not to say that these signatures do not appear within forest and water signatures. In some cases, the individual signatures for non-forest and non-water body objects are recognized easily because of their contrasting traits within forest and/or water signatures. A case in point is transportation facilities--roads and pipelines which "cut" through forested areas.

Signatures of Water Bodies.--Large water bodies, particularly reservoirs, such as Pickwick Landing Reservoir, Wilson Lake and Wheeler Lake, and the entire course of the Tennessee River (See Figures 1 and 2), as it is shown on the photograph, can be interpreted directly from the imagery. Lower order streams, contrariwise are more difficult to resolve; their resolution depending upon the associated contact signatures or stream surrogates. In many cases the location of lower order streams can be inferred from associated agricultural land use signatures on the channel margins or riparian vegetation or clearings. In some areas of the photograph where forested signatures dominate, identification of fifth-order channel patterns could be

easily delimited; fourth and third order stream surrogates were sometimes identifiable, but it was impossible to visualize second or first order streams or surrogates of these. In regions of dense and complex agricultural and urban land uses it was impossible to see even the highest ordered streams (with the exception of the Tennessee River).

Large water bodies display different colors, in terms of hue, value, and saturation. A model signature for the main part of the reservoir waters was 5B 3/4, according to the Munsell color chart. Marginal areas of the large reservoirs and the upstream regions would display color characteristics which consisted of a stippled pattern of light values and high chroma indices of yellow-red, blue, and blue-green. It was thought that runoff and associated sediments might have been responsible for the light yellow-red colors in the waters. A check of weather data and an interview with TVA hydrologists proved this hypothesis not to be true.

Weather data revealed that a light rain of less than one-half inch occurred on the 6th of March and traces of snow on the 8th of March. Surface soil temperatures for the week before the date of the overflight were below freezing for a majority of the time; thus it is highly probable that much of the soil water was "locked in." TVA hydrologists, after a review of past-discharge and sediment load records and local precipitation, were of the opinion that the streams contained no more than 100 ppm sediment at the time the photograph was taken, a less than normal amount for these streams. It was concluded therefore that these changes in color were the result of seeing through the water into the shallows of the reservoirs and not because of suspended sediment in the water *per se*.

Blue hues correlated closely to deep water channels. Low-lying and wet land islands in the middle of waterways closely approximated signatures of shallow waters, but sharp edges and lower chromas and blue or blue-green

hues are distinctive of islands because of vegetation.

The section of the Tennessee River included in the photograph is used for barge traffic. But after a rather intensive search, not one signature object could be identified or recognized as a barge, either in the reservoirs, streams, or at a dock side. It is possible that there were no barges present, but it is more likely that under the given lighting and contrasting conditions of the environment that barges, and/or other river traffic facilities were not resolved.

Forest Signatures.--Four major types of forest signatures were recognized on the photography--two mixed forest associations, a southern flood-plain forest association, and a pine plantation signature. Two minor signatures were also identifiable outside regions where the major forest signatures dominated. These are the riparian vegetative signatures found alongside the streams, rivers, meander scars, and small woodlot signatures found in areas dominated by agricultural croplands.

The mixed forest signatures result from forest associations, as defined by A. W. Kuchler,[4] consisting of oak-hickory (Quercus-Carya) and oak-hickory-pine (Quercus-Carya-Pinus), seen in the northern and southern portions of the photograph, respectively. On Kuchler's map of Potential Natural Vegetation of the Conterminous United States, a dividing line between these two forest associations trends across the photographed area. No such line was directly apparent from the photograph in the assigned location. It was determined, however, that a boundary line (not necessarily potential) between these forest associations is actually several miles south of the location described by Kuchler.[5] The forest signature in the northern section of the photograph

[4]A. W. Kuchler, Potential Natural Vegetation of the Conterminous United States (New York: American Geographical Society, 1964).

[5]It is possible that the potential boundary line is located correctly on Kuchler's map.

displayed red tint (10R 4/8) qualities within a matrix of blue hue of low chroma and value indices (5B 2/2) in greater proportions than that which was visible in the southern portions. It is believed that the proportions of red tint result from a greater degree of "openness" of the forested areas in the northern part of the photo in relation to the forest characteristics of the southern part of the photo. The openness quality was hypothesized to be associated with one of two (or both) possible characteristics of the forest: (1) The forests in the north consist of greater numbers of broadleaf and deciduous trees and at the time of the photograph these trees were without leaves, and (2) the average density of trees per unit area in the northern part of the photograph was less than that of the southern part. Field investigation into the area tends to reduce the latter assumption to minor significance. In addition, if the openness property of the forest to the south was great (i.e. consisting of greater numbers of broadleaf trees) the red tint should have been equal to or greater than that of the forest association signature to the north because the tilt of the photo for the southern portions is closer to the vertical, and one would therefore see the forest ground easier; such is not the case.

Another discrepancy between Kuchler's potential vegetation map and the actual forest association exists with respect to what Kuchler calls the "southern floodplain association" (Quercus-Nyrsa Taxodim). Photo signatures for this type of association are readily apparent in the southern portions of the photograph, in and around the main channel of the Tombigbee River and its tributaries. The fact that there are low-lying floodplain forests in this area was verified in the field. The symbols representative of this forest association on Kuchler's map do not extend into the study area region. Nevertheless, the areal dimensions of the floodplain forests are large enough

to be taken into consideration as a mappable item (the dimensions of floodplain sections vary between one to five miles).

The general signature color for floodplain forest is a blue hue (10B 3/4), which closely approximates purple-blue, and therefore, it is distinctively different from the color of water of large reservoirs. Tints of red are apparent in the southern floodplain forests associated with the main channel of the Tombigbee River and some of the tributaries of the same indicating an "open" quality similar to that of the upland mixed forests. The degree of tinting in floodplain forest in relation to the upland forest is much more subtle, however. Another property of the floodplain forest association is its edge traits; smooth flowing lines which apparently follow the contours of terrain and which form "inlets" in the region of inflowing tributary streams. This spatial property of the floodplain forest contrasts strikingly with the borders of the mixed forest associations which are most often jagged.

The pine plantation signatures are not unlike the signatures of groups of pines in the mixed forests, especially in terms of color (7.5 B 2/2). The property which clearly differentiates the pine plantation signature from others is spatial form. In Alabama and Mississippi pine plantations are found in rectalinear blocks of varying sizes because of the property survey lines of the cadastral units. Where the pine plantation follows a metes and bounds survey system, such as exists in Tennessee, it is not possible to differentiate the signatures from those of pine signatures following a valley in the mixed forest association; therefore, not all pine plantations can be recognized.

Where crop agricultural land use systems dominate the landscape scene, a woodlot signature is identifiable. This particularly is true in the area of Lauderdale County in Alabama and adjoining areas in south-cental

Tennessee. Small woodlot plots, ranging in size from one to fifty acres in size, are characteristic of farm layouts in this area. The woodlots have straight edges but, in general, they are not in rectalinear block-like forms as are the pine plantations. Because of the scale and resolution level of the photograph it is difficult to identify an individual plot, instead one recognizes a "mottled pattern" resulting from the assemblages of different land use traits which are characteristic of the area in which woodlots are found.

Signatures of Lithology, Landforms, and Mining Activities.--Numerous reports have been written concerning the advantages of small scale photography for geologic investigations. Many of these works have dealt with arid regions where vegetative cover does not conceal the geologic features.[6] In areas with a humid climate, vegetation and urban-agricultural land use patterns may provide the best clues for geologic interpretation. Differences in soil color, drainage network configurations, and contrasts between different land use types (*e.g.* forest vs. plowed land) may provide significant clues to the regional geologic pattern.

In the area of the Alabama Apollo photograph, the contrast between Tuscombia limestone which has weathered to produce a flat to gently undulating area of red soils is easily delimited from the upland and forested hills which are underlain by more resistant beds of Bethel sandstone. The sandstone formation extends east-west in the area south of the Tennessee River through Colbert and Lawrence Counties.[7]

[6]William Hemphill and Walter Danilchils, "Geologic Interpretation of a Gemini Photo," Photogrammertric Engineering, Vol. XXXIV, No. 2, February, 1968, pp. 150-154.

[7]U.S. Department of Agriculture, Soil Survey of Franklin County, Alabama (Washington: U.S. Government Printing Office, 1965), pp. 74-75.

The Bear Creek lowland, west of Russellville and adjacent to the Alabama-Mississippi boundary line, which lies on the Mississippian Bangor limestone is easily distinguished from the Pennsylvania Tuscaloosa formation which surrounds it.[8] The Bear Creek lowland is recognized on the basis of its agricultural land use signature and is surrounded by the forested and hilly topography of the Tuscaloosa formation.

Areas of open pit mining exhibit distinctive photographic signatures. On the photograph, the large areas of open pit limonite mining southwest of Russellville are easily identified. Smaller and scattered local stone and gravel mining operations located to the southwest of the Russellville mining area are also identifiable by their lighter tonal signature, geometric configuration, and distinct chroma and hue. Differentiation between small limonite mines, gravel and dimension stone quarries is not readily made at the scale and resolution level of the Apollo photography.

The northern extension of the Alabama Black Belt is plainly visible on the western quadrant of the photograph. This low area is marked by its distinctive land use pattern and by the surrounding darker forested landscape.

Other examples of the vegetative clues to physiographic identification include: (1) The forest riparian surrogate for a large meander scar east of Diamond Island in the Tennessee River located between Pickwick Landing Dam and Savannah (See Figures 1 and 2). This meander scar, through its vegetative surrogate, is revealed only in terms of its vegetative signature. (2) To the east of the Tennessee River, in the north-central portion of the photograph, the general westward slope of the Fort Payne Formation can be interpreted from the dendritic pattern of the agricultural land use along the tributary

[8]E. F. Burchard, Russellville Brown Iron Ore District, Franklin County, Alabama, Alabama Geological Survey, Bulletin 70, 1960, pp. 26-27.

streams flowing westward into the Tennessee River. (3) In the western half of Franklin County, Alabama, (See Figure 3) the areal extent of the rolling to hilly upper coastal plains topography which is covered with gravelly soils (very poor for agricultural purposes) and which are now forest-covered are readily delimited from surrounding areas with better soils and lower local relief. (4) The dissected upper coastal plain in the southeast portion of Franklin County can be detected by the dendritic type agricultural land use configuration which is bordered by forest-covered sandstone rock land.

Signatures of Settlement Forms.--The photo signature for urban places is registered in blue with various high chroma values which are attributable to the higher reflectivity of most manmade objects--(10B 7/1 to 10B 9/1) and is of brighter intensity than most other features of the Alabama landscape. The ease and reliability of urban identification depends upon the size of the urban place, intersecting transportation routes, and the adjacent and surrounding land use. For example, urban land use is most easily identified when the surrounding land use is predominantly forest or plowed land. In areas where surrounding land use is composed of pasture, small plowed fields, and small woodlots the identification of small urban areas is more difficult. An example of this situation in target signatures is the town of Moulton in Lawrence County which could not be located on the photograph (See Figures 1 and 2).

On the western edge of the photo in the Black Belt region, the complex agricultural landscape produces a signature which prohibits identification of settlements of any size. The settlements blend with the woodlots, pasture, highways, and farm fields to produce a diffused signature.

The urban complex of Florence-Sheffield-Tuscumbia-Muscle Shoals is easily delineated. For Florence, the differentiation between the urban and agricultural land on the east is somewhat difficult because of the similarity

in the signature of the two land use types, but the western boundary is quite distinctive where the urban area makes contact with a river bottom forest association.

The confluence of highways, railroads, and pipeline powerline right-of-ways provide good clues to the location of small urban places. It is highly probable that the town of Savannah, Tennessee, population 4,300 would not have been located on the photograph had not three major highways intersected there. However, most urban centers with a population of 5,000 or more could be identified on the photograph.

Signatures of Transportation Features.--Only a small portion of the transportation network on the photograph could be identified. Transportation routes are most easily identified on humid-forested landscapes when they pass through forested areas; their linearity being the major key to their identification. In forested areas where considerable agricultural land borders roadways, the highways, *per se*, cannot be seen on the image but their presence can be inferred from the strips of non-forested land (highway surrogates). Even some small gravel and unimproved roads may be identified by this method in forested areas where secondary roads extend to most farmsteads and logging and mining operations. The difficulty of identification of various transportation networks has been discussed by Simonett.[9]

In large areas of intensive agricultural land use even major highways may not be detected. In the red soil region adjacent and south of Wilson Lake, a dense regular road network exists owing to the rectangular survey system. This highway-land use configuration gives a "blocky" signature on

[9]D. S. Simonett, F. M. Henderson, and D. D. Egbert, "On The Use of Space Photography for Identifying Transportation Routes: A Summary of Problems," Proceeding of Sixth Symposium on Remote Sensing of the Environment (1969), Ann Arbor, Michigan.

the photograph in the intensive agricultural area and this same "block" textural pattern is also recognizable in large urban areas.

Keys to distinguishing between highways and pipeline-powerline right-of-ways are the width of signature of the major highways and the brightness of their signature. In many cases, the differentiation between highways and railways is not easily accomplished.

It is of interest to note that of the five structures crossing the Tennessee River (three hydroelectric dams and two bridges), the linearity of only two can be detected from the photo, namely Pickwick Dam and Natchez Trace Bridge. The location of Wilson Dam and the highway which crosses it can be detected only by the narrowing of the river below the impoundment. The location of the bridge at Savannah,Tennessee, was implied by the location of the highway which was detected on each side of the river.

<u>Summary and Conclusion Concerning Target Signature Identification</u>.--Not all of the signatures represented on the photography and identified were listed in the foregoing section; such a list would be astronomical in length. Only some of the features which are significant to the composition of the area and interrelate with other features, as they may be identified by geographers and planners were listed. A deliberate attempt was made, however, to avoid reporting signatures associated with the rural settlement landscape. A discussion of these signatures follows in the next section.

Conclusions reached concerning the interpretation of significant targets within the area of the Apollo 9 photograph are "idiographic" in terms of time, space, and technique. Under a different set of environmental and temporal conditions using different films and/or filters, the targets identified in this report may or may not be discernable. Nevertheless, given similar atmospheric conditions and the same type of camera and film system, it is highly probable that most of the identified targets would be recognized.

It is a firm opinion of the investigators that more accurate identification of targets would have been possible had the photo been vertical rather than oblique.

The Use of Spacecraft Imagery in Conjunction With or as a Substitute for Census Data

The Apollo 9 image of northern Alabama provides a unique advantage for testing the technique of using spacecraft sensors for detecting certain types of spatial phenomena which are distributed across the landscape. Census data also permits this type of detection. However, when the Census is used, the phenomenon is reported for the whole unit, and therefore it is not possible to realize how the item of concern is distributed within the unit. An example is herewith cited in terms of forest cover within the various counties and civil divisions imaged in northern Alabama. According to TVA census information for Colbert, Franklin, Lauderdale, and Lawrence Counties, forest cover constitutes fifty-six, sixty-eight, forty-one, and forty-eight percent of each of these counties, respectively (See Table 1). From the data reported, it is not clear whether the forest cover is distributed in many small plots or exists in several large holdings. A case in point is made of Lauderdale County which is located north of the Tennessee River (See Figures 1 and 4). Although Lauderdale County contains the least amount of forest cover of all of the reported counties (a fact which is clearly evident from the space image), it is not clear from the Census data how the forest cover is distributed within the different segments of the county. It can be seen from Table 1 that a wide variance exists between the proportion of the county covered with forests as a whole (41 percent) and its various subunits, ranging from a low of sixteen percent for Minor Civil Division 7 to a high of sixty-nine percent for Minor Civil Division 1. These proportions have been

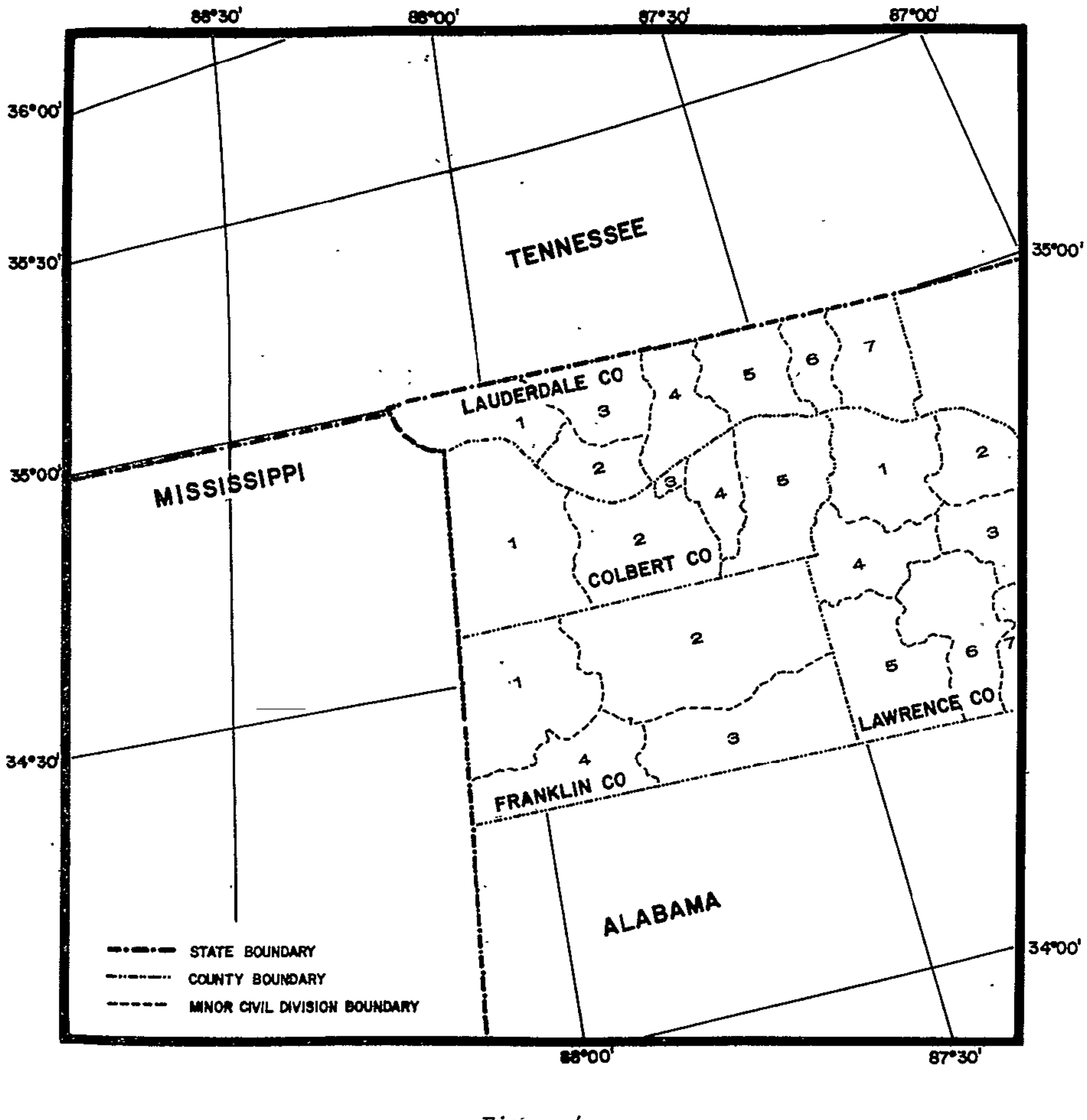


Figure 4

Minor Civil Divisions of Colbert, Franklin, Lauderdale, and Lawrence Counties, Alabama. The margins of this map correspond with the margins of the Apollo 9 photograph (Figure 1). The boundary between Lauderdale and Colbert Counties is the Tennessee River.

TABLE 1

FOREST COVER IN COLBERT, FRANKLIN, LAUDERDALE, AND LAWRENCE COUNTIES, ALABAMA[1]

Counties and Minor Civil Divisions	Total Land Area (Acres)	Land in Farms (Acres)	Proportion of Land in Farms	Woodland on Farms (Acres)	Total Forest Cover (Acres)[2]
Colbert County:	394,240	179,263	45.5%	62,766	222,000
1		48,076		21,066	
2		50,719		25,188	
3		223		21	
4		11,536		2,757	
5		64,709		13,734	
Franklin County:	412,160	213,203	51.7%	107,947	281,200
1		46,823		28,765	
2		86,574		37,221	
3		48,464		22,189	
4		31,342		19,772	
Lauderdale Co:	440,320	248,462	56.4%	70,116	183,200
1		22,847		15,966	
2		45,622		9,228	
3		31,172		9,406	
4		38,975		14,386	
5		30,384		8,561	
6		26,394		4,799	
7		53,068		8,570	
Lawrence Co:	439,040	250,804	57.1%	63,506	212,700
1		59,532		11,768	
2		29,305		12,308	
3		29,985		6,447	
4		30,174		8,380	
5		29,814		6,947	
6		52,585		12,640	
7		19,409		5,016	

[1]Source: 1964 Census of Agriculture, Alabama Farm and Farm Characteristic Data, Available by Minor Civil Division, Unpublished data.

[2]Source: Tennessee Valley Authority, Forestry Division, Norris, Tennessee, Unpublished data.

verified by measuring the extent of the forest cover within the minor civil divisions on the spacecraft image to an acceptable degree of accuracy. In addition, the spacecraft photo provides information regarding the distribution of forest cover within the minor civil divisions. It is clearly evident that the western half of Minor Civil Division 1 in Lauderdale County is more than 90 percent in forest, and contrariwise the forest cover in eastern half is in small woodlot patches. Large woodland blocks also characterize Minor Civil Divisions 3 and 4; each of which is characterized by 30 and 37 percent of farms in woodland. The remaining minor civil divisions for Lauderdale County have low percentage of forest cover, most of which is in small woodland plots.

Other types of census data can be visualized and measured with some degree of accuracy. The area of bright red tone located in association with the Tennessee River is indicative of open land, specifically cropland which is without plant cover. Most of this area is planted in corn, soybeans, or cotton. At the time the photograph was taken, these cropland areas had been plowed, but they had not been seeded. It is, therefore, not possible to detect the areal extent of the specific types of crops from the photography, but it is possible to gain some notion of the extent of land that is reserved for row crops. Using again, Lauderdale County as an example, it is discernable that cropland, identified in terms of the bright red hue, varies in terms of the area occupied across the county landscape (See Figures 1 and 4). Also, it is apparent that the concentrations vary in a manner similar to the already cited forest resources of the same county, i.e. in terms of small and large areal blocks (not necessarily fields). Pastures and idle lands, both of which are morphologically undifferentiable in terms of the resolution of the photography, are displayed in various hues (red and yellow-red) and values (bright to dark) but, with neutral or low chroma (gray). Although these

areal signatures vary in terms of their tonal qualities, they are distinctly different from either the forest or plowed cropland signatures.

A subjective and cursory glance of the space photograph (Figure 1) in conjunction with the base map (Figure 4) reveals that those minor civil divisions which have reported large areas in cropland (Table 2) distinctly show a large proportion of land in bright (high chroma) and red hues. Examples of highest readings are Minor Civil Divisions 2 (Lauderdale County); 1 (Lawrence County); and 4 (Colbert County). And minor civil divisions which display the "pasture and/or idle land" signature also report large amounts of land devoted to the same in the Census. Examples of the highest readings are Minor Civil Divisions 4, 5, 6, and 7 (Lauderdale County); 3, 4, and 6 (Lawrence County); and 2 (Franklin County). It is possible, therefore, to measure the proportions of land within each minor civil division devoted to broad categories of land use--cropland, pasture and/or idle, and forest--from space photography.[10]

A census data correlate which can be crudely associated with spacecraft signatures is average size of farms. It seems to be apparent that the more uniform the texture and the more homogeneous the tonal qualities, the larger the average size of farm for the minor civil division. In contrast, the more diverse and heterogeneous the patterns and tones of the signatures, the smaller the farm size. This fact seems to follow, logically, the observable fact that large rural holdings will tend to be concerned with relatively few operations over large areas. Small rural holdings are concerned with an equal or greater number of functions in relation to large holdings, especially

[10]Although this task was objectively accomplished via a dot grid method for areal measurement, the readings are not accurate because the photograph was not rectified. Costs and time constraints prohibited rectifying it. Nevertheless, no reason is apparent to the investigators why these data cannot be quantitatively extracted from the photo.

TABLE 2

PROPORTIONS OF LAND USE TYPES ON FARMS

IN MINOR CIVIL DIVISIONS OF SELECTED COUNTIES OF NORTHERN ALABAMA

Counties and Minor Civil Divisions	Cropland	Pasture	Woodland
Lauderdale County:			
MCD-1	7.5%	19%	70%
MCD-2	29%	45%	20%
MCD-3	27%	36%	30%
MCD-4	18%	41%	35%
MCD-5	22%	44%	28%
MCD-6	22%	48%	18%
MCD-7	25%	51%	16%
Lawrence County:			
MCD-1	40%	34%	20%
MCD-2	34%	18%	42%
MCD-3	27%	39%	22%
MCD-4	29%	31%	28%
MCD-5	37%	31%	23%
MCD-6	31%	35%	24%
MCD-7	34%	30%	26%
Colbert County:			
MCD-1	19%	32%	44%
MCD-2	15%	31%	50%
MCD-4	48%	31%	17%
MCD-5	36%	32%	21%
Franklin County:			
MCD-1	14%	19%	61%
MCD-2	16%	36%	43%
MCD-3	20%	25%	46%
MCD-4	14%	20%	63%

Source: U.S. Bureau of Census, 1964 Census of Agriculture, "Unpublished Data, Alabama Minor Civil Divisions," Washington, D.C., February 13, 1970.

in the southeastern United States; thus per unit area, the small holdings will produce a highly varied "stippled" photographic pattern. Although it is nearly impossible to quantitatively state what the average size holding is within an area, it is possible to predict the relative average sizes of holdings among the several minor civil divisions of the four counties under consideration. The minor civil divisions with the greatest range of photographic tones and texture pattern have the lowest average size farms, ranging from 86 acres to 105 acres (See Table 3). One exception to this rule is Minor Civil Division 4 in Colbert County which displays a somewhat uniform pattern, but nevertheless has low average size of farm--94 acres. The uniform and homogeneous pattern regions are generally associated with minor civil divisions which are largely devoted to intensive commercial agriculture--thus large fields and pastures. These minor civil divisions have average farm sizes which range from 122 to 226 acres; the median being 204 acres. Several minor civil divisions have textures which are both varied and uniform; i.e., a portion of the minor civil division may display a uniform pattern and the other portion may be varied. It is of interest to note that the average farm size of such places occupy, in general, an intermediate position between the "small farm" and the "large farm" minor civil divisions. The average sizes being 102, 152, 162, and 166 acres.

It would seem reasonable to assume that the average farm size of the minor civil division should correlate, rather strongly, with the population density of the same statistical unit. The agreement among the predominant texture and tonal patterns of the photograph, average farm size, and average population density is quite high if several constraints are recognized. These constraints for the northern Alabama minor civil divisions are whether or not the minor civil division (1) is predominantly forested, (2) reflect uniform agricultural patterns (fields), thus consist of large farms, (3) of varied

TABLE 3

AVERAGE SIZE RURAL HOLDING AND POPULATION DENSITY

FOR MINOR CIVIL DIVISIONS

County & Minor Civil Divisions	Average Size Farm Holding (acres)[1]	Population Density (per sq. mile)	MCD Classification[2]
Lauderdale County:			
MCD-1	212	12.2	F
MCD-2	172	37.3	A
MCD-3	105	44.1	S
MCD-4	162	71.3	U
MCD-5	92	51.0	S
MCD-6	86	47.2	S
MCD-7	91	48.8	S
Lawrence County:			
MCD-1	226	49.5	A
MCD-2	211	31.3	A
MCD-3	89	59.7	S
MCD-4	94	33.6	S
MCD-5	122	12.7	F
MCD-6	118	46.7	S
Colbert County:			
MCD-1	223	17.8	F
MCD-2	166	94.9	U
MCD-4	95	126.0	U
MCD-5	204	48.7	A
Franklin County:			
MCD-1	190	22.8	F-S
MCD-2	152	48.5	S-A
MCD-3	189	35.9	F-S
MCD-4	102	15.0	F-S

[1] *Census of Population: 1960*, Volume I, Characteristics of the Population Part 2, Alabama.

[2] Identification of Minor Civil Divisions (MCD)

F	Forest	Population density low, average farm size large.
U	Urban	Population density high, average farm size large.
A	Agricultural	Population density medium, average farm size large.
S	Small Farm	Population density medium, average farm size medium.

agricultural patterns, thus consist of small farms, or (4) whether they are adjacent to large urban areas.

Minor civil divisions which reflect a predominant forest signature are composed of large farms and low populations. In the study region, forested minor civil division population densities ranged from 12.2 to 17.8 people per square mile (See Table 3). Agricultural divisions have large farms and medium population densities, 31.3 to 49.5 people per square mile. The small farm regions have average farm sizes which range from 92 acres to 105 acres and population densities for the same area are in the medium category, ranging from 33.6 to 59.7 people per square mile. The minor civil divisions which are adjacent to urban complexes, in this case the Florence-Tuscumbia-Sheffield area, have large average farm sizes and high population densities. The exception in this case is Muscle Shoals Minor Civil Division (Minor Civil Division 4 in Colbert County) which has a small average farm size, 95 acres, but nevertheless a high population density. The latter situation can be partially explained by the fact that the Muscle Shoals Minor Civil Division is one of the smallest divisions within the four-county region, approximately 50 square miles, and a large proportion of this area is contained within government lands--the TVA Muscle Shoals reservations. Therefore, most of these lands are unavailable for rural agricultural or residential uses.

The Census areal sub-units of Franklin County reflect photographic patterns which are transitory, between forest-type and small farm region (Minor Civil Divisions 1, 3, and 4) or between small farm and agricultural region (Minor Civil Division 2). And concomitantly, the Census data for average farm size and population densities are also in "between" values.

<u>Summary and Conclusion</u>.--It is readily apparent to the investigators that many of the Census reported characteristics or rural landscape can be extracted from orbiting spacecraft imagery. Only a few have been reported

here from just one photograph. Some photographs of the same area but of different seasons, especially late spring and early summer and late summer and fall, should reveal more significant data about the general rural landscape characteristics that would be of importance to regional planners and geographers. Data returned from space, such as the EROS system, should provide information concerning trends that are taking place within a rural area during periods between census dates, i.e. every ten years.

It is significant to note that the census unit that correlates with the scale and resolution of the type of photography made from Apollo 9 of northern Alabama is the minor civil division. These units are about the same general size throughout the populated sections of the eastern United States. In a manner of speaking, the minor civil division unit may serve as a "ground truth" agent for calibrating sensor data.[11]

Finally, even though there is some degree of agreement between the minor civil division data and what can be seen on spacecraft imagery, it also is obvious that the aggregate tonal and textural patterns reflected by the natural and cultural landscape do not coincide with these political units. Analysis of geographic landscapes should proceed from actual observations, and for some purposes, regional planning processes should take into consideration the morphological traits of landscapes which, to a large degree, are reflections of the behavior (functional) patterns characteristic of the earth's surface.

[11] In many respects, the suggestion that the minor civil division serve as orbital sensor calibration unit for investigating spatial traits of the rural landscape follows some of the conclusions which were reached by John Weaver concerning the township as a statistical average in agricultural geography. John Weaver, "The County as a Spatial Average in Agricultural Geography," Geographical Review, XLVI (1956), pp. 536-565.

Photomorphic Land Use Regions

Introduction.--On a photograph from space of a humid and forested portion of the earth's surface, the works of man are readily observable. The absence of forest usually indicates that man has altered the landscape and this imprint is observable on the photograph. Different land uses are registered in different tonal-textural patterns and these patterns may be mapped from hyper-altitude space photography.

Clearly discernible on the photograph are signatures which differentiate open lands from forest regions. Approximately forty percent of the photograph could be classed as open area; this would include small woodlots discussed in a previous section. A variety of color and texture characteristics are representative of the open lands which are a result of soil and soil moisture traits, field patterns, cover crops, roads, woodlots and other terrestrial phenomena. For reasons of simplicity and analysis, rural land use areas on the photograph are categorized into what is herewith called "photomorphic regions."

> The aerial photographic patterns which form the photomorphic unit is a composite image of the photo-identifiable features of the physical and cultural landscape, and though complex, is homogeneous in character and has recognizable areal extent. This image consists of a variety of tones associated with vegetation, crop types, and soil moisture conditions, of patterns produced by the geometry of the fields, of patterns resulting from the drainage systems, and of forms associated with visible rural and urban settlement. In other words, those perceptible features such as photographic tone, field size and form, drainage pattern and density, and populated structures combine to produce the composite image which can be mapped geographically.[12]

The basic tenets of photomorphic regions analysis rests on certain postulates which were introduced into America by Carl Sauer, concomitantly

[12] Donald D. MacPhail, "Photomorphic Mapping in Chile," Unpublished manuscript, University of Colorado, 1969, pp. 3-4.

with emphasis on areal differentiation as the concern of geographical research.[13] The methodological antecedents of these apparently were from Europe, particularly Germany. Sauer's main contribution was to emphasize the value of the morphological method. He notes:

> The systematic organization of the content of landscape proceeds with the repression of a priori theories concerning it. The massing and ordering of phenomena as forms that are integrated into structures and the comparative study of the data as thus organized constitute the morphologic method of synthesis, a special empirical method.[14]

Furthermore, with respect to the morphological approach, Sauer notes that "...there is a unit of organic or quasi-organic quality,...a structure to which certain components are necessary." And that "similarity of form in different structures is recognized because of functional equivalence."[15] The similarities of tonal and textural patterns on orbital imagery for regions of some considerable areal extent is accepted herewith to be indices of similarities of functional traits.

Eleven major rural land use photomorphic regions were delineated on the photograph (See Figure 5, Photomorphic Land Use Regions). Attention was focused only to the rural open land with all urban areas mapped as one unit, "Urban." Each region was classified according to similar properties which related to the assemblages of color and textural traits. Within the boundaries of some of the areas, some distinctive subregions are identifiable. Although some sharp and distinctive boundaries separated some of the regions from each other, in general, most of the boundary situations were zones of transition between patterns. The "sharpness" of these regional boundaries

[13]Carl O. Sauer, "The Morphology of Landscape," <u>University of California Publications in Geography</u>, II No. 2 (1925), pp. 19-53.

[14]<u>Ibid</u>., p. 30.

[15]<u>Ibid</u>.

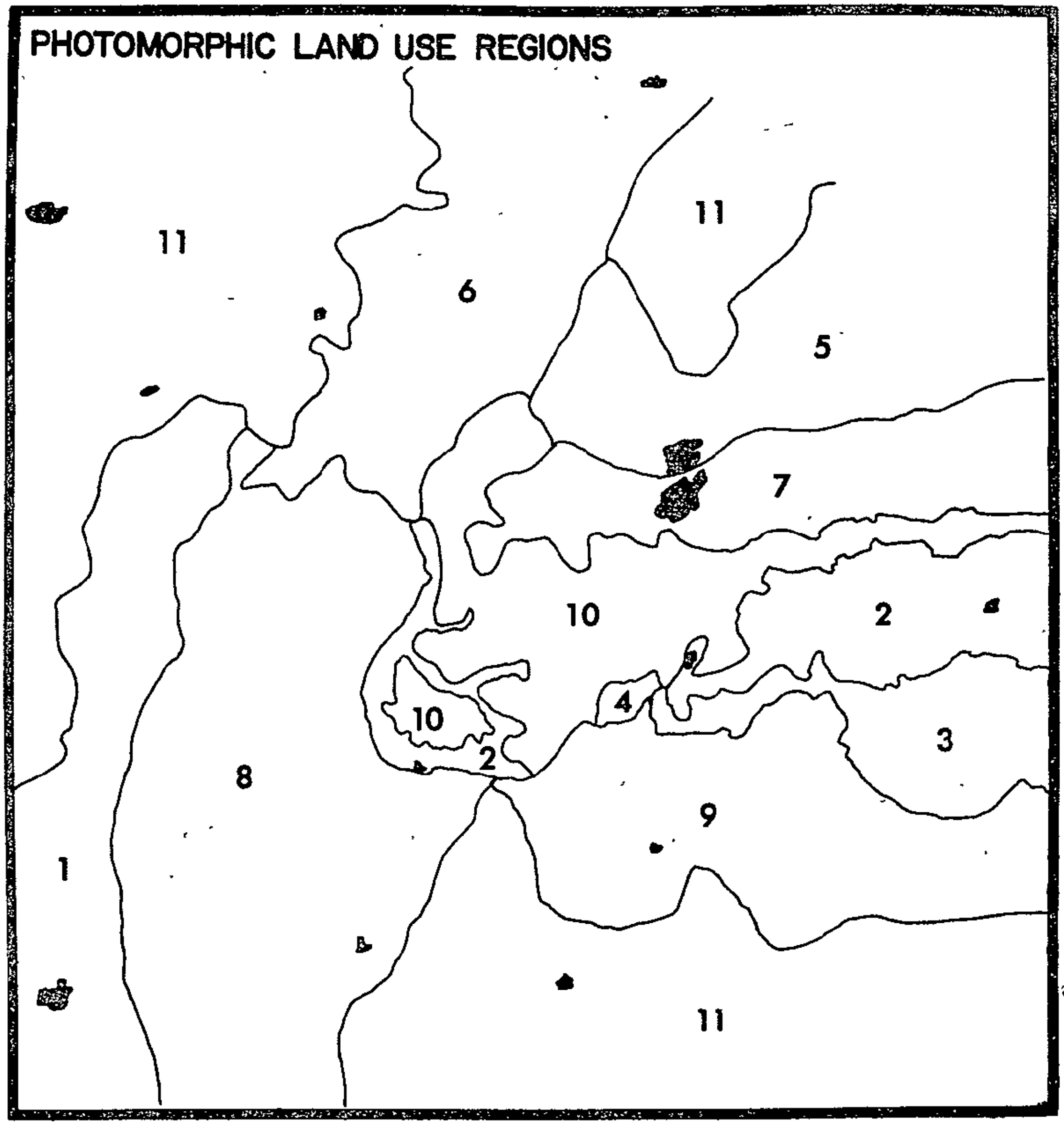


Figure 5

1	BLACK BELT AREA
2	MOULTON VALLEY REGION
3	BANKHEAD FOREST AREA
4	RUSSELLVILLE MINING SECTION
5	TENNESSEE VALLEY SMALL FARM REGION
6	TENNESSEE RIVER FLOODPLAIN AREA
7	TENNESSEE VALLEY LARGE FARM REGION
8	TOMBIGBEE - TENNESSEE REGION
9	UPPER COASTAL PLAIN FARMING REGION
10	LITTLE MOUNTAIN WOODLAND AREA
11	UNDEFINED
	URBAN

varies from faintly observable to easily definable. The importance of the photomorphic regions in terms of their geographical significance has not been fully explored, but it is thought that they may serve as a method of defining large areas, especially rural planning regions.

Particularly, the photomorphic region concept, when it is applied to small-scale orbital photography (small-scale air photo mosaics can also be used), is believed to be a more valid and rapid way for delineating problem areas of large areal extent than conventional techniques. To be sure, problem regions can be identified through the use of standard procedures. For example, data can be collected in the field, or from the Census and plotted on maps, and then analyzed in terms of their spatial relationships and significance. The field technique, however, is expensive and time consuming. And with respect to data derived from the Census, too frequently, the political divisions which are used, counties or even their smaller subdivisions--minor civil divisions, do not coincide with the "natural" morphological and corresponding functional divisions of landscape. Figure 6 shows how photomorphic regions "cut" through the several minor divisions of the counties of northern Alabama mentioned earlier. It is significant to note that major portions of some of these minor civil divisions belong to as many as three different photomorphic units.

The characteristics of eight photomorphic regions are briefly described in the following section. Four counties of Northwestern Alabama were selected for special consideration because of the image clarity in the central and eastern portion of the photograph (See Figure 3).

<u>The Tennessee Valley Large Farm Region</u>.--Although no one regional pattern dominates the photo, the reddish-yellow section (here called the Tennessee Valley Large Farm region) in the center of the photo, attracts first attention. In this section, which borders the Tennessee River, the Federal township and range system is more readily apparent than in any

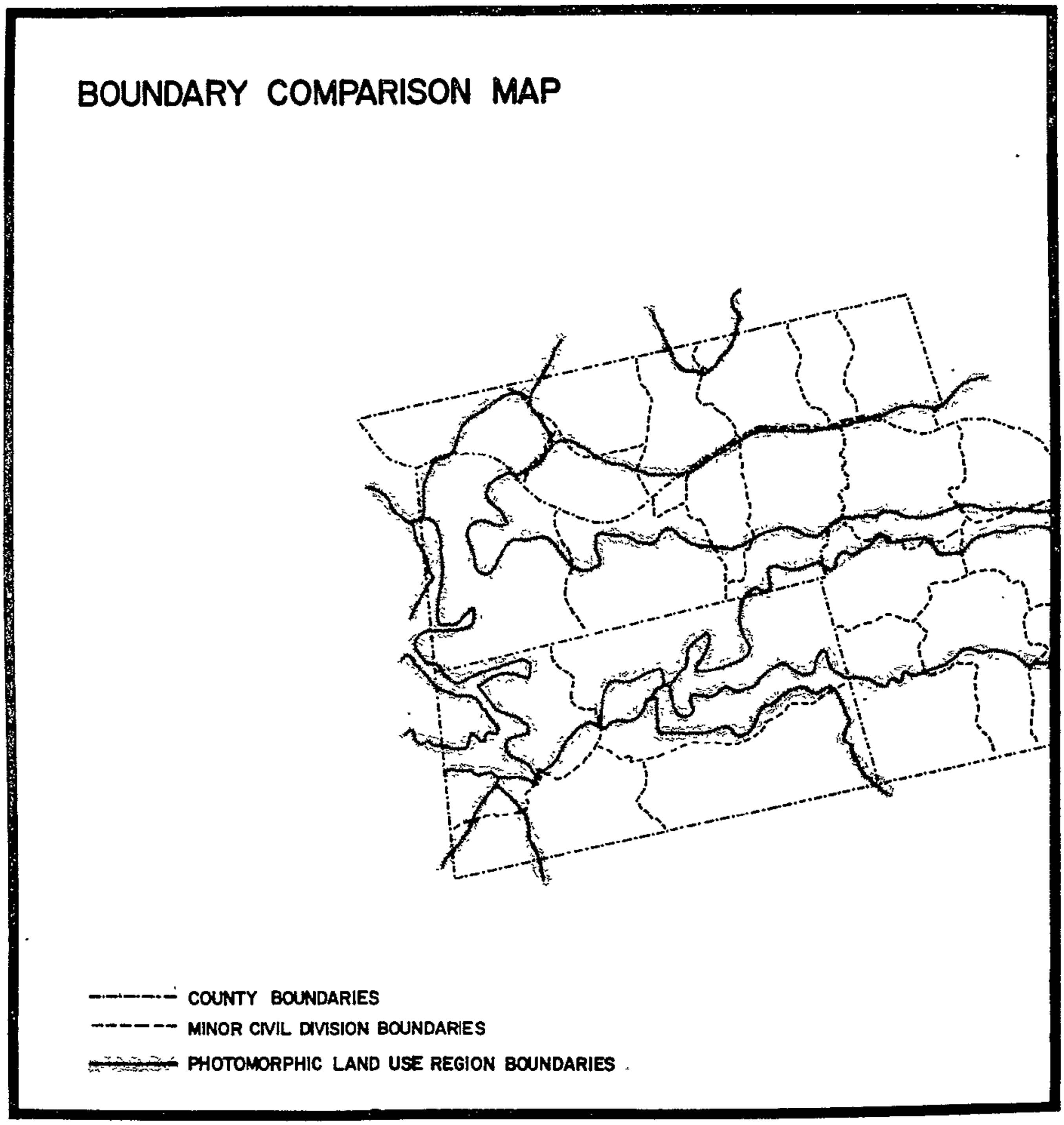
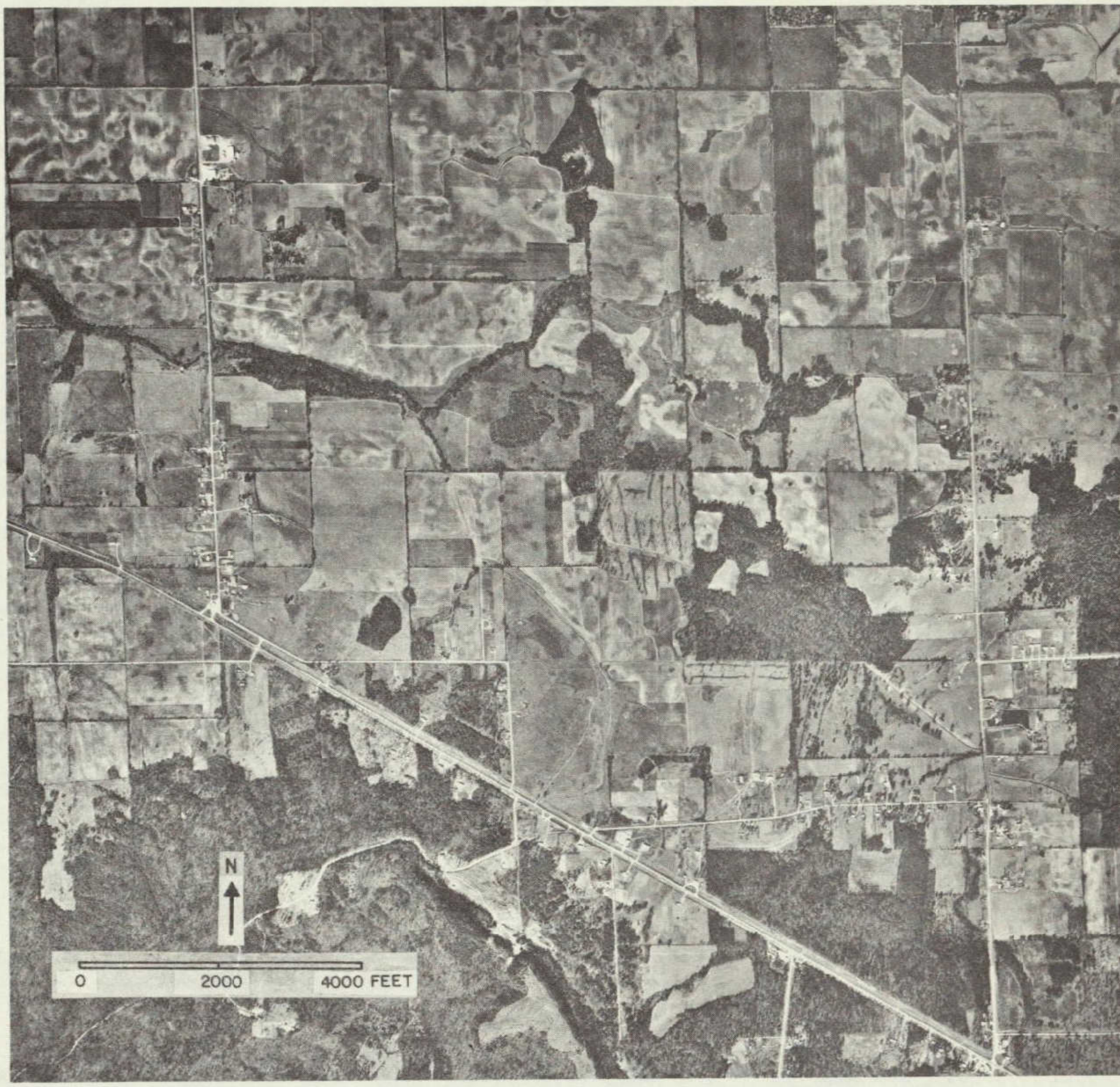


Figure 6
This map presents a comparison of county, minor civil division and photomorphic land use region boundaries for Lauderdale, Colbert, Franklin, and Lawrence Counties, Alabama.

other section of the photo. The survey system and the interior farm field patterns are responsible for the distinctive "checkerboard" pattern. Another factor responsible for the field pattern is the flatness of the terrain. Groupings of fields are recognizable on the photo, but individual fields per se are not identifiable. The individual fields on farms in the area are not especially large; the average size being about ten acres (See Figure 7), but they are the largest size fields, on the average, in the photo area. The high chroma and reddish hues that are associated with the fields in this area surrogates for intensive crop agriculture. The dominant photo color results from the color of plowed lands being prepared for row crops. In the Large Farm region, soils are prepared for planting earlier than in other regions of the photo area--particularly for corn, cotton, and soybeans--and thus the soil colors are distinctly displayed on the 11 March photo.

The topography in the Large Farm region varies between flat and undulating; in fact, slopes in this area are lowest of any of the regions identified. Exterior drainage and runoff are slow, but sheet wash erosion, because of extensive row crop cultivation, is extensive and thus soil erosion is a major problem. The leveliness of the terrain also contributes to accumulation of fine and fertile sediments in low lying areas. Moisture tends to concentrate in these areas, preventing early spring plowing and keeping soil temperature low, both factors of which are detrimental to cotton production and partially explains why this crop is being replaced by soybeans.

The mottled effect in the fields on both the space and air photos (See Figures 1 and 7) apparently is a result of poor drainage where slight depressions concentrate moisture for long periods of time, sometimes in the form of small ponds or lakes. Forest cover in this region is concentrated around stream channels, although a few woodlots are associated with some



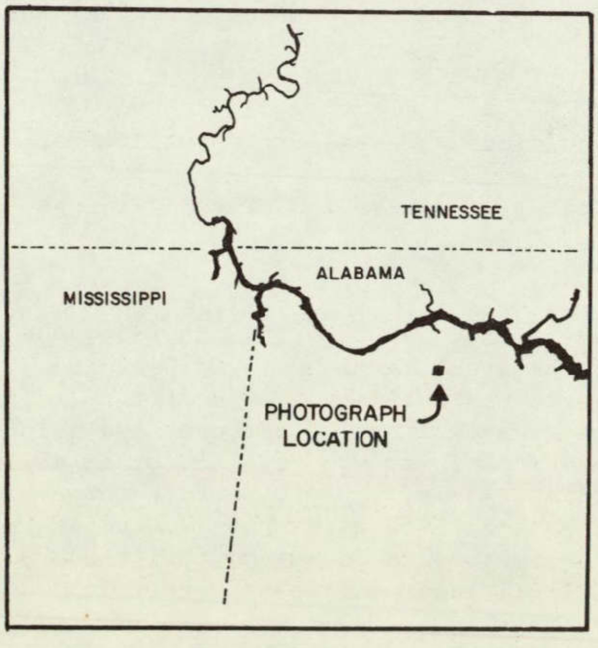


Figure 7

Large scale TVA aerial photograph, southwest of Leighton, Alabama, in the Tennessee Valley Large Farm Region. A section of the Little Mountain Woodland Area is located in the bottom portion of the photograph. (Photo source: TVA, 1967).

farms. A significant amount of woods is adjacent to fence lines, mainly cedars and junipers. These linear forest features serve as wildlife cover, and therefore, are significant with respect to conservation and recreation in the area (See Figure 7).

Low chroma-high value indices (gray) of blue and red hues are representative of pasture fields (grasses at this time of year were dormant). The color tones which represent pasture areas are completely overshadowed by plowed tracts. Approximately twenty to twenty-five percent of the area would be classified as pasture (or related land uses) from the photo; a figure which agrees closely with the Census.[16] The drainage network associated with the Tennessee Valley Large Farm region is generally perpendicular to the course of the Tennessee River. The higher ordered streams are regularly spaced at distances of about ten miles. This pattern has conditioned distribution of land uses within the region;a fact which is discernable on the space photography. Forests, as already mentioned, are spatially associated with stream courses. Pastures are located in strips adjacent in forest areas, and croplands, in general, occupy the wide interfluves between the drainage systems. Obviously, the farms supporting animal industries--beef and dairy cattle--are concentrated in the regions of drainage courses, and the crop farms are located away from these.

Although small settlements, individual houses, and barns are not detectable as such on the photo, groupings of houses and other buildings--

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[16] Census of Agriculture-Alabama, 1964, pp. 257-259. In 1964, the amount of land devoted to pasture of the total farmland in Colbert and Lawrence Counties was 17 and 14 percent, respectively. An additional six percent of farmland in Lawrence County was in improved pasture; two percent for Colbert. Four percent of the land in Colbert was idle and/or in soil improvement, and ten percent in Lawrence. Thus, in toto, twenty-three and thirty percent of the entire county areas in 1964 might have imaged as what is herewith called pasture. It may be reasonable to assume that these percentages would not have changed drastically over a five-year period.

hamlets, villages, towns--are recognizable. In part, it is believed that grouping of rural, nonfarm residences (not necessarily subdivisions), which are aligned along the roads, are responsible for enhancing portions of road network in this area, examples of which can be seen in Figure 7. A significant proportion of the rural nonfarm population is gainfully employed in urban occupations, in Florence, Tuscumbia, Sheffield, and Muscle Shoals. The transportation network and the condition of roads adequately serve this population. The availability of a good highway network and the availability of land in this region for residential development as well as expected significant economic growth in the adjacent urban area should be incentives for continuing and promoting the "strassendorf" type rural nonfarm residential land development in this region. Thus, it is expected the Large Farm region will experience moderate to large rural population growths in the future. These increases in population in this area and the concomitant expansion of rural nonfarm residential land uses should not cause appreciable losses in the agricultural production in the region if the growth and development remains in association with the road network.

Tennessee Valley Small Farm Region.--The Small Farm region as outlined on this photo lies in Alabama and Tennessee north of the Tennessee River. The photographic signature is complex and diffused and the recognition of distinct patterns is difficult. Although the land use pattern is based on the rectangular survey system, the checkerboard pattern which is distinctive for the Tennessee Valley Large Farm Region is not easily recognizable in this area.

The gently rolling terrain which characterizes the topography of the Small Farm region has promoted the development of small cadastral farm units; large operations are difficult to manage in this type terrain.

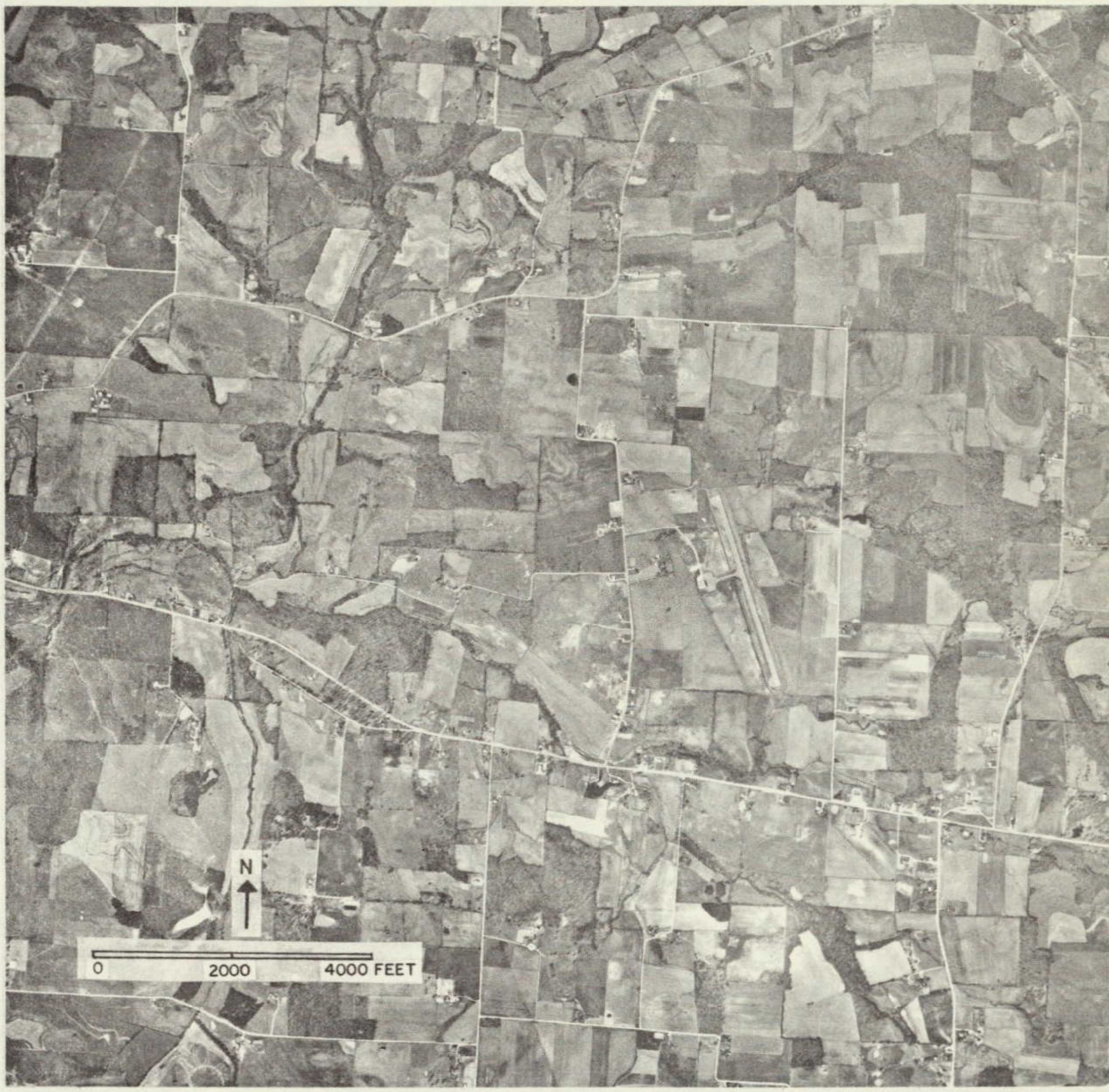
The average farm size in the Small Farm region is less than 100 acres.

Individual fields are small, and woodlots are well dispursed throughout the landscape. The principal crops are cotton, soybeans, and corn, with the latter occupying the greatest acreage. Approximately one-third of the farmland is pastured and of this, one-third is pastured woodland.[17] This pasture-woodland-small field land use pattern is reflected on the image in a complex color-textural pattern (See Figure 8). The woodland lots and forest riparian growth present a "speckled" pattern on the photograph, and in this pattern only large woodland areas could be distinctly identified. The low order stream drainage network is more dense in the Small Farm region than in the Large Farm area. Although erosion control is a concern of the landowners (exemplified by conservation farming, particularly contour and strip plowing-See Figure 8), problems of sheet erosion and concentration of moisture in depressions, which are characteristic of the Large Farm region, are of no major concern in this area.

Rural nonfarm residences are also characteristic of the Small Farm area. But unlike the settlement patterns of the Large Farm area, where these units are grouped in clusters along roads, most of these units are evenly and regularly dispersed across the landscape. Inhabitants of the rural nonfarm residences, as well as many of the owners and operators of the small farms, work at urban occupations in the Florence-Sheffield complex. The structure of rural land occupance in the Small Farm region consists, therefore, of two major units--small farm operations ("baby" farms) and rural nonfarm places. Both operations are strongly urban-centered in terms of incomes of the inhabitants of these places.

Accessibility to major highway arteries from "off main road" locations is more difficult, in general, in the Small Farm region than in the Large

[17]U.S. Bureau of Census, 1964 Census of Agriculture, "Unpublished Data, Alabama Minor Civil Divisions," (Washington, D.C., February 13, 1970).



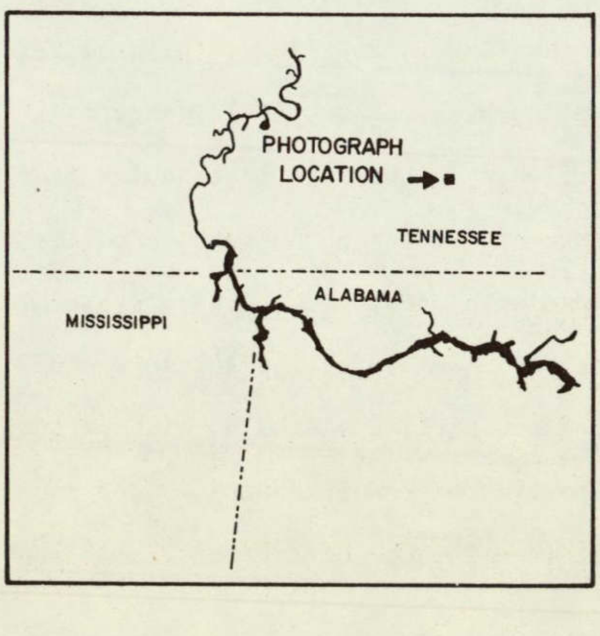


Figure 8

Aerial photograph of a section of the Tennessee Valley Small Farm Region southeast of Lawrenceburg, Tennessee. The complex color-texture pattern on the Apollo photograph is a result of the pasture-woodland-small field land use pattern which characterizes this region. (Photo source: TVA, 1967).

Farm area. In addition, the general condition of secondary and primary roads in this area is poorer than it is in the Large Farm area. These transportation factors, as well as the fact that most of the land is in small landholdings (and thus making it difficult to subdivide for residential subdivision use), will tend to retard future rural residential land development. It is therefore, the opinion of the investigators that although population growth will take place in this region, it will be at a slower rate than that which is predicted for the Large Farm area.

Upper Coastal Plain Farming Region.--The upper coastal plain section, an upland farming area, lies on dissected coastal plain uplands in Franklin County. The farms in this region are located on relatively flat, wide-crested interfluves, the result of widely spaced streams which are incised approximately 100-200 feet into the underlying sediments. The stream margins and slopes are generally forest covered with farm operations restricted to the interfluves. The soils on the interfluves are gray sandy loam and generally poor for agricultural crop production. The gently rolling topography is best suited to small and medium farm-size operations.

The photographic signature for the upland farming region is quite distinctive (See Figure 9). The farmland pattern is dendritic in character, with the agricultural land widening on the larger interfluves (cleared vs. forest lands). The cultivated land and improved pasture field pattern reflects the configuration of the interfluves and not the rectangular land survey system which is evident in other areas of the photograph. Smaller field size and contour farming are also distinguishing features of this area. In Franklin County, the farm sizes range from an average of 102 acres in Minor Civil Division 4 to 189 acres in Minor Civil Division 3, with pasture and woodland making up a considerable portion of the landholdings (25 and 46 percent, respectively). The general farm layout consists of farmsteads

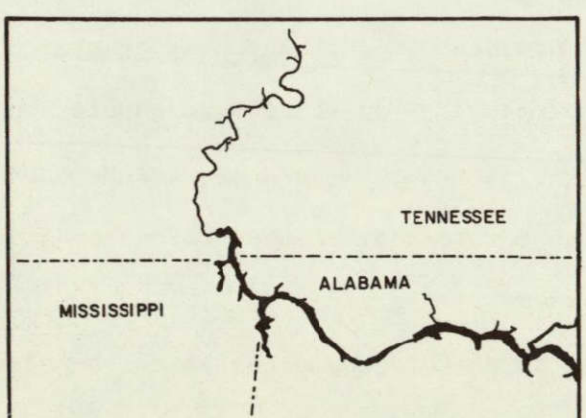


Figure 9

Large scale aerial photograph of a portion of the Upper Coastal Plain Farming Region in the south-central portion of Franklin County, Alabama. The distinctive pattern of interfluve farming is easily recognized (Note outlined areas on photo). This pattern was distinctive on the small scale Apollo 9 photograph. (Photo source: TVA, 1967).

and small crop fields on the upland interfluves; pastures are associated with the convex slopes which lead into the narrow "V" shaped stream valleys, and the stream valleys are generally forested. Most of the farms produce cattle and poultry for the market with almost 50 percent of the farms producing corn and 35 percent producing cotton. Per capita incomes, as revealed in the Census and also from field-derived evidence of the morphology of the farms and farmsteads, are the lowest in the four county region.

A considerable portion of the Upper Coastal Plain Farming region is devoted to forestry and tree farm activities. Large tracts of land are planted to pines and similar fast-growing trees, which are harvested annually on a sustained-yield basis or through bloc-cutting procedures. Stages of pine growth are clearly visible on the space photograph, especially where fields have been recently planted. A small proportion of rural inhabitants are gainfully employed in occupations associated with the forest industries.

Although the population density of this rural region (See Table 3, Franklin County) is relatively low in relation to most of the other regions of northern Alabama, it is over-populated in terms of the economic base which the area can provide. Except for a small "residual" population which can derive an adequate income from local rural service and forestry industries, it is highly improbable the area can support anything greater than a low density population. Thus, the forecasts for the future population growth in this region are for small, if any, increases. However, future economic growth may expand, especially if large forest plantings are encouraged and marginal farming activities discouraged.

Moulton Valley Region.--This farming region occupies the topographic area known locally as the Moulton Valley physiographic division of Colbert and Lawrence Counties. The region lies to the south of the Tennessee Valley Large Farm region and is separated from it by the Little Mountain

physiographic division. This latter section is a forested and dissected plateau and is included in the upland cuesta physiographic region.[18] The forest-agricultural land use boundary of this region is easily traced on the space photograph. Topographically, the Moulton Valley photomorphic region is not very different from the Tennessee Valley Small Farm region. The terrain is gently rolling; surface drainage is good to excellent; and soils and soil moisture are well suited for pasture use.[19]

The Moulton Valley region photographic signature is distinguished on the basis of its small blocky texture created by the prevalence of block woodland areas, a high percentage of pastures(reflected in its generally blue-gray colors), and numerous small plowed fields. The area is bordered on three sides by relatively solid forest growth stands. Most of the well drained soils in the section are used for crops, particularly corn, cotton, pasture, and hay crops with the poorer and poorly drained soils usually forested. This region has distinctively small sized farms, averaging about 85 to 95 acres throughout much of the valley.[20] The amount of plowed land is much smaller in the Moulton Valley than in the Tennessee Valley Large Farm region to the north and this condition is reflected in the blue-gray (pasture land) signature. The region, thus, is very similar in morphology to that of the Tennessee Valley Small Farm area, north of the Tennessee River. The main differences are functional. There is a smaller number of people who commute to the urban centers from this area in relation to the

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[18] U.S. Department of Agriculture, "Soil Survey, Lawrence County, Alabama," U.S. Government Printing Office, Washington, D.C., November 1959,pp.4-5.

[19] Tennessee Valley Authority, Soils in the Tennessee Valley (Chattanooga: TVA Map and Survey Division, 1968).

[20] U.S. Bureau of Census, 1964 Census of Agriculture, "Unpublished Data, Alabama Minor Civil Divisions," Washington, D.C., February 13, 1970.

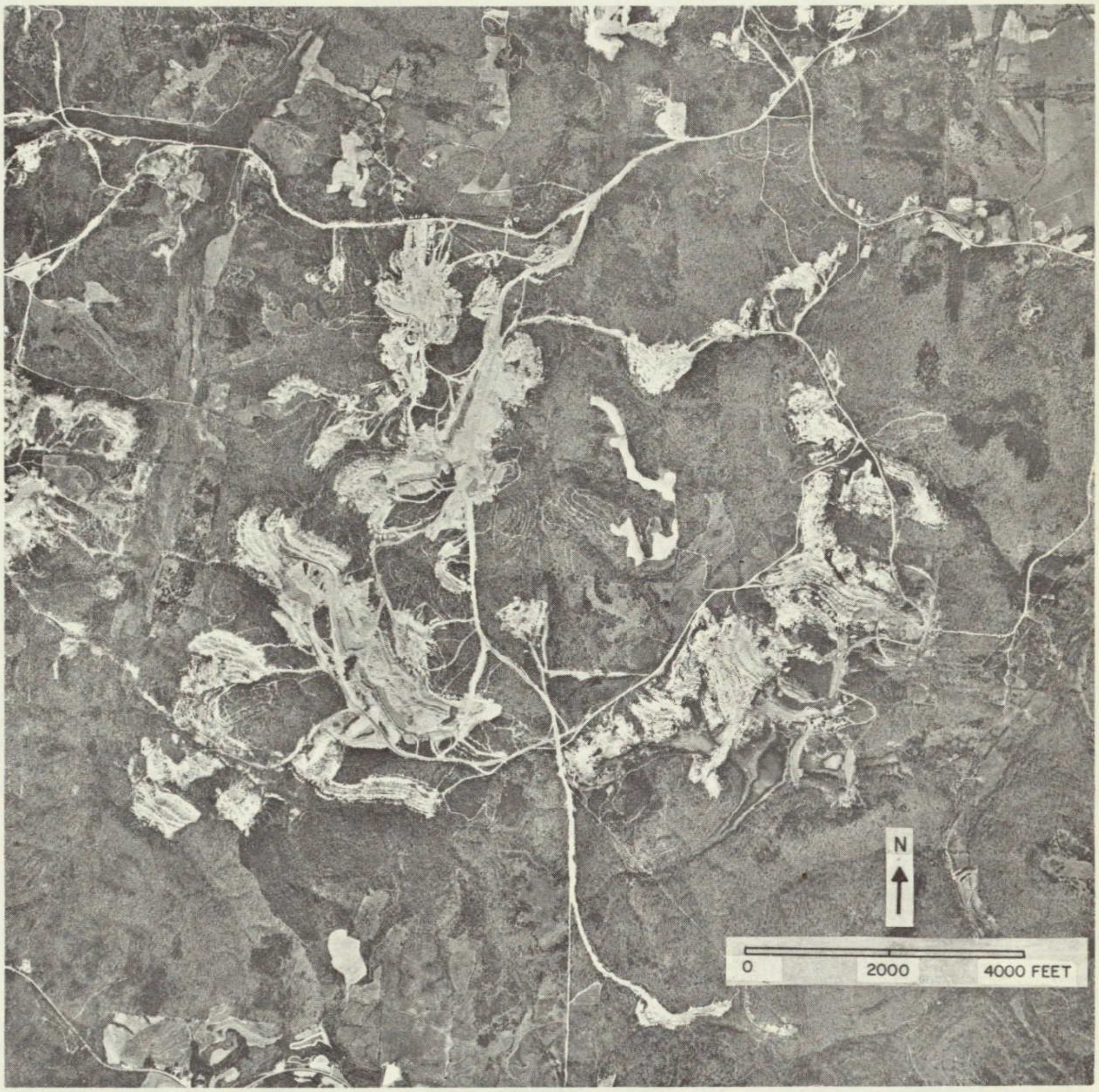
Small Farm area because of the greater distance from these centers and the physiographic barrier of Little Mountain which separates the Moulton Valley from the urban area. Improved transportation corridors through this barrier should provide the impetus to convert and promote rural nonfarm residential growth.

A greater concern is given to animal production in the Moulton Valley area than in any of the other regions in the study area--particularly beef cattle. And this type of activity should be encouraged; however, the small and medium size holdings characteristic of the area are not of the size to efficiently carry such activities. Only through the consolidation of the existing small units can the Moulton Valley truly achieve this economic activity potential.

Russellville Mining Section.--The Russellville Limonite Mining Region of Franklin County, Alabama, presents a distinctive photographic signature (See Figure 10). The areas of recent open pit activity are areas of highest reflectance on the photograph except for clouds. The general elongated configuration of the excavation scars, the brightness of the signatures and the distinctive color all serve to aid in the identification of the mining activities.

Although a small percentage of the total labor force in Franklin County is involved directly with mining activities, two percent, the benefits received from the industry are much greater than are reported by the Census, especially in terms of those in service and ancillary trades.[21] While the open pit mining activities contribute greatly to economy of the area at the present time, the limonite ores in the area can be exhausted.

[21]U.S. Bureau of Census, 1960 Census of Population--Alabama, I (Washington,D.C: U.S. Government Printing Office, 1963) pp.2-210. Two percent of the total labor force in Franklin County are engaged directly in mining occupations which exceeds by more than double the proportion of the labor force for the state engaged in the same industry.



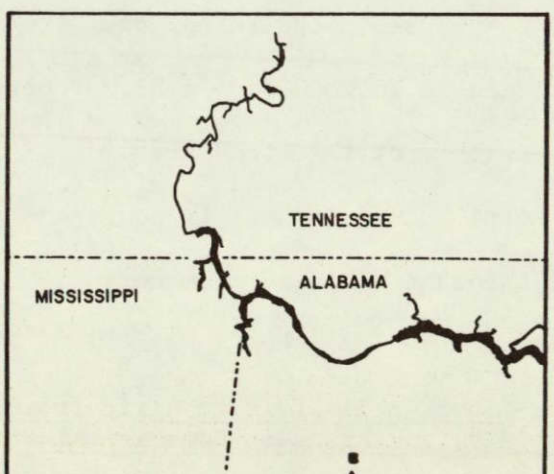


Figure 10

Aerial photograph of the main portion of limonite mining in Franklin County, Alabama. The Russellville Mining Section was recognized and mapped on the Apollo photograph on the basis of its bright photographic signature and the geometric configuration of the open pit scars. (Photo source: TVA, 1967).

Thus, the economy can collapse in the near future. In addition, some measure of land restoration needs to be made, especially in terms of revitalizing the scarred landscape. Some efforts have been attempted to convert old and shallow strip mines to pine plantations; the deep pits, however, are more difficult to rehabilitate.

Little Mountain Woodland Area.--This woodland area lies mostly in Colbert and Franklin Counties, Alabama, with narrow strips extending eastward into Lawrence County and northward into the western end of Lauderdale County. The hilly section is underlain with sandstone and some limestone and the northwestern section is covered with coastal plain material. The resistant sandstone contact with the less resistant limestone to the north is traceable on the Apollo photograph by the forest-agricultural land contact.

The major portion of this photomorphic region is in forest with agricultural land located on the level land and the limestone areas which have been exposed by the erosion of the coastal plain sediments. Generally, about 70 percent of the cropland is devoted to the production of corn, cotton, and soybeans. The production of cattle and hogs is increasing in this section as the result of the demand for feeder animals. Pasture percentages are generally lower in this photomorphic region than any other in the four county study area of northwestern Alabama.[22] Due to the topography, frequently over fifty percent of a farm holding is in woodland, a higher percentage than in most other photomorphic regions of the study area.[23]

The road density network in the Little Mountain area is poor; and only along five corridors which "slice" through the area, from north to

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[22]U.S. Department of Agriculture, Minor Civil Division Agricultural Data, 1964 for Colbert, Lawrence, Lauderdale, and Franklin Counties, Alabama, Unpublished.

[23]Ibid.

south, is there any significant buildup of the population distribution. Potentially, the Little Mountain area could provide development sites for the nearby urban centers, either in terms of rural nonfarm residences or summer or seasonal homes. Such development, however, would require significant attention to the transportation network, especially rural secondary roads.

Bankhead Forest Area.--This photomorphic region is located in Lawrence and Franklin Counties, Alabama. The Apollo photographic signature has distinct boundaries (dark blue of the forest cover in contrast to the lighter grays and reds of the pastured and cultivated land adjacent to the forest). Most of this forest area consists of cutover oak and hickory but sections of pine are distributed throughout the region. The areas of pine growth register in a dark blue in contrast to the lighter blues of the hardwoods. This region is strongly dissected and consists of narrow ridge tops, extensive hills, and steep slopes.[24] Due to the rough terrain and generally poor soils (low fertility, strong acidity, and low moisture capacity) only a small portion of this region is in farmland with the major portion suited only for forestry.

Most of the Bankhead Forest region is owned by the Federal government--National Forest Land. Fringe areas, which are also forested, are in private ownership. Locations where future acquisitions of these private holdings should be made can easily be determined from the space photograph.

Tennessee River Floodplain Area.--The Tennessee River Floodplain section lies on the western side of the plateau slope of western Tennessee.[25]

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[24]U.S. Department of Agriculture, Soil Survey, Lawrence County,Alabama, (Washington, D.C: U.S. Government Printing Office, 1959), p. 5.

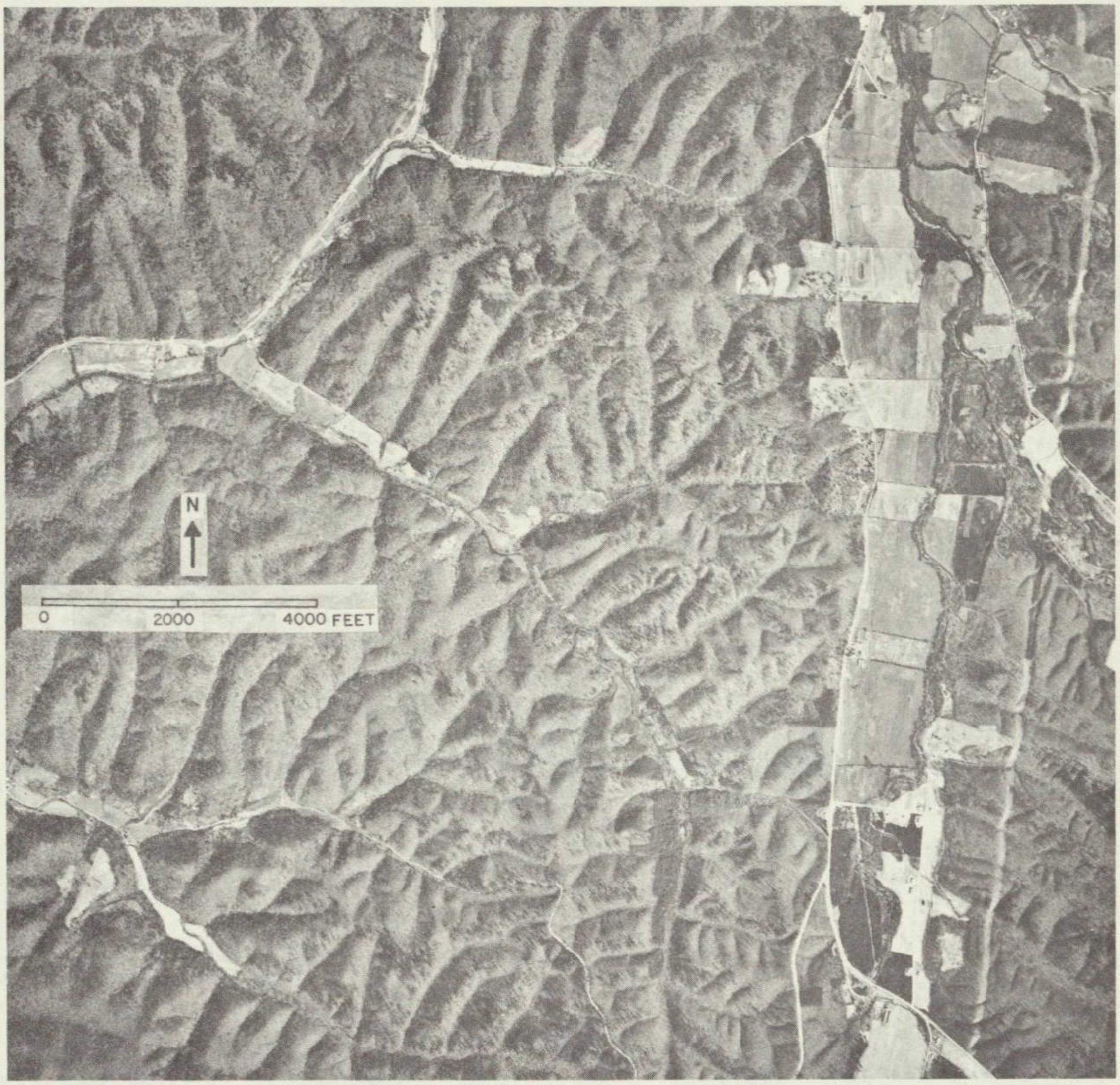
[25]Walter F. Pond, Geologic Map of Tennessee, Tennessee Department of Education, Division of Geology, 1933.

The major streams of this section drain westward into the Tennessee River on the plateau surface which dips gently westward. The area is deeply dissected and is prevailingly hilly (See Figure 11). The farms and settlements are generally located on the floodplain of the Tennessee River and its major tributaries. This dentritic land use pattern is the dominate characteristic of this photomorphic region. The farm sizes vary from an average of 260 acres in Perry County, Tennessee, to about 154 acres in Hardin County, Tennessee. Cattle and hogs, corn, and pasture are important agricultural land uses of this region with cotton important only in minor areas. The most hilly land is in a forest of mixed hardwoods with some areas of shortleaf pines and cedars.

Similar to the Little Mountain and the upland farming regions, the Floodplain area has a significant potential as a forest resource area. Some pine plantations have already been established in the area as evident from the space photograph, but these represent but a small portion of the total land available for such development.

Transportation routes are oriented along the stream valleys and are generally topographically controlled. The total amount of farm land in relation to the area under forest is relatively small, and therefore, population densities are low.

Significance and Possible Applications of the Photomorphic Region Concept.--From the aforementioned descriptions of the photomorphic regions, it can be ascertained that each region has its own distinctive land use characteristics. Within each photomorphic region there is, among other things, a relative uniformity in the assemblages of land holding sizes, types and amounts of crops and animals produced, percentages of forest cover, and population densities. The space photograph provides a means by which unique areas with similar economic characteristics may be delimited and subjected



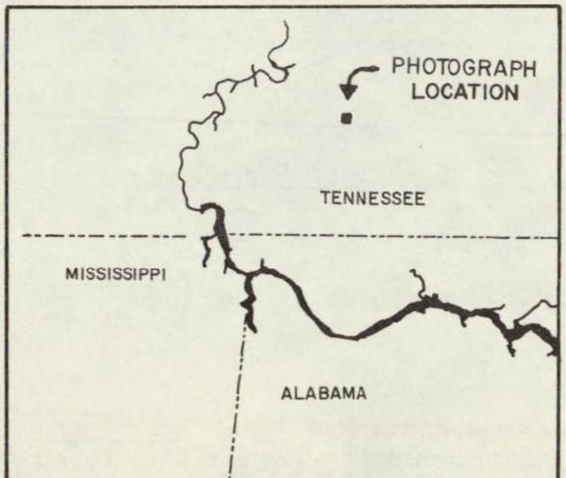


Figure 11

Air photograph of representative section of the Tennessee River Floodplain photomorphic region. In this region the farms and settlements are located on the narrow floodplains of the major streams while the dissected plateau surface remains under a forest cover. (Photo source: TVA, 1967).

to analysis in terms of planning priorities. Particularly, as has been demonstrated, a significant number of physical and land resources can be inventoried in terms of their areal setting and spatial interrelationships with other locations. To be sure, ground truth (large scale) information about the characteristics of the phenomena in question is needed. Here again, the photomorphic regions provide the base upon which statistical sampling of areal data can be accomplished in any number of ways.[26] Even some human resource characteristics of regions can be inferred through surrogate relationships, and the distribution of these can be quantitatively measured.

The photomorphic region approach has the advantage of providing a base from which planning priority problem areas may be spatially delimited and evaluated. Table 4 presents an initial attempt to evaluate selected problem areas of each of eight photomorphic regions. On the basis of evidence gathered from field and library research, each problem area is rated on a basis of high (H), medium (M), or low (L) priority. By this procedure the problems and assets of rural regions (delimited on the basis of photographic signature and therefore being independent of political boundaries) may be categorized, evaluated, and compared and thus provide a realistic spatial unit for which resource development and physical planning may be initiated.

Automatic Interpretation Procedures for Spacecraft Photography

The vast amount of information that is contained on one spacecraft photograph and the problems that are associated with extracting these data

[26] P. Haggett, "Scale Component in Geographical Problems," Frontiers in Geographical Teaching, eds. R. Chorley and P. Haggett (London: Methuen, 1965) pp. 167-168.

TABLE 4

PRIORITIES OF SELECTED PROBLEMS
ASSOCIATED WITH THE VARIOUS PHOTOMORPHIC REGIONS

Planning Priority Problem Area	-- Photomorphic Regions --							
	Tenn. Large Farm	Tenn. Small Farm	Upper Coastal Plain	Moulton Valley	Russell-ville Mining	Little Mtn. Woodland	Bankhead Forest	Tenn.River Floodplain
Physical Systems								
Drainage (flooding)	M	M	L	H	M	L	L	H
Soil erosion (slow forms)	H	M-H	M-H	M-H	H	L	L	M
Slope failure	L	L-M	M-H	L	L-H	M	M	M
Water supply (basic sources)	L	L-M	H	M	M	L	L	M
Soil types (in relation to agricultural production including forestry)	L	L-M	M-H	M	L-M	M-H	L-M	L-M
Biological Systems								
Reforestation & afforestation	L	M	H	M	H	M-H	M-H	H
Forest management	L	M	H	M	M	H	H	H
Aquatic management	H	H	L	L	L	L	L	M-H
Human Systems								
Accessibility to urban complexes	L	M-H	H	M	L	L-H	L	M-H
Land tenure-size of operations in relation to agriculture	L	M-H	M-H	L-M	L-M	L	L	M-H
Amount of available land suitable for agriculture	L	L-M	H	L-M	M-H	H	H	H
Outdoor recreation	M	H	L	L	L	M	H	M
Settlements (low-ordered-village, hamlet & town)	M	H	L	M	M	L	L	M
Agriculture Systems								
Intensive (crop agriculture)	H	M	L	M	L	L	L	M
Extensive (animal)	H	M	M	H	L	L	L	M

from such photographs through unconventional photo interpretation procedures is a constraint which will be on any spacecraft remote sensing system. When a satellite, such as ERTS (Earth Resource Technological Satellite) is put into orbit, and returns data of the earth at an incomprehensibly rapid rate, it is apparent that the normal techniques for extracting information, mainly the human eyeball, will be a "bottle neck" to the system. Some type(s) of automatic interpretation procedure will have to be followed if only part of the benefits to be achieved from the use of such a system are to be realized. Preliminary and cursory analysis of microdensitometry printouts indicate that this can be one technique which may be of great value for interpreting signatures quickly.

Equipment Used.--A preselected strip, 30 x 12 mm., from 70 mm. Ektachrome transparency of the Apollo 9 photography of northern Alabama was utilized to test the procedure (See Figure 12). The strip was scanned by the University of Tennessee's Tech/Ops Scandig Model 25, high speed digital, x-y scanning microdensitometer. Settings of 100 micron raster and 100 micron aperture were used on four runs; each with a different filter. The filters used were as indicated in Table 5:

TABLE 5

	Dominant Wave Length	Range
(1) Neutral Density	--	--
(2) Red-Wratten No. 92	646.2 mμ	618-700 mμ
(3) Green-Wratten No. 93	544.8 mμ	510-600 mμ
(4) Blue-Wratten No. 94	460.2 mμ	419-500 mμ

The data were recorded on a Kennedy Model 3110 digital tape recorder and processed through an IBM Model 360 computer with the data dump in pictorial gray-tone format. A gray scale of ten levels was used with each increment representing an equal proportion of the approximately 25 density levels

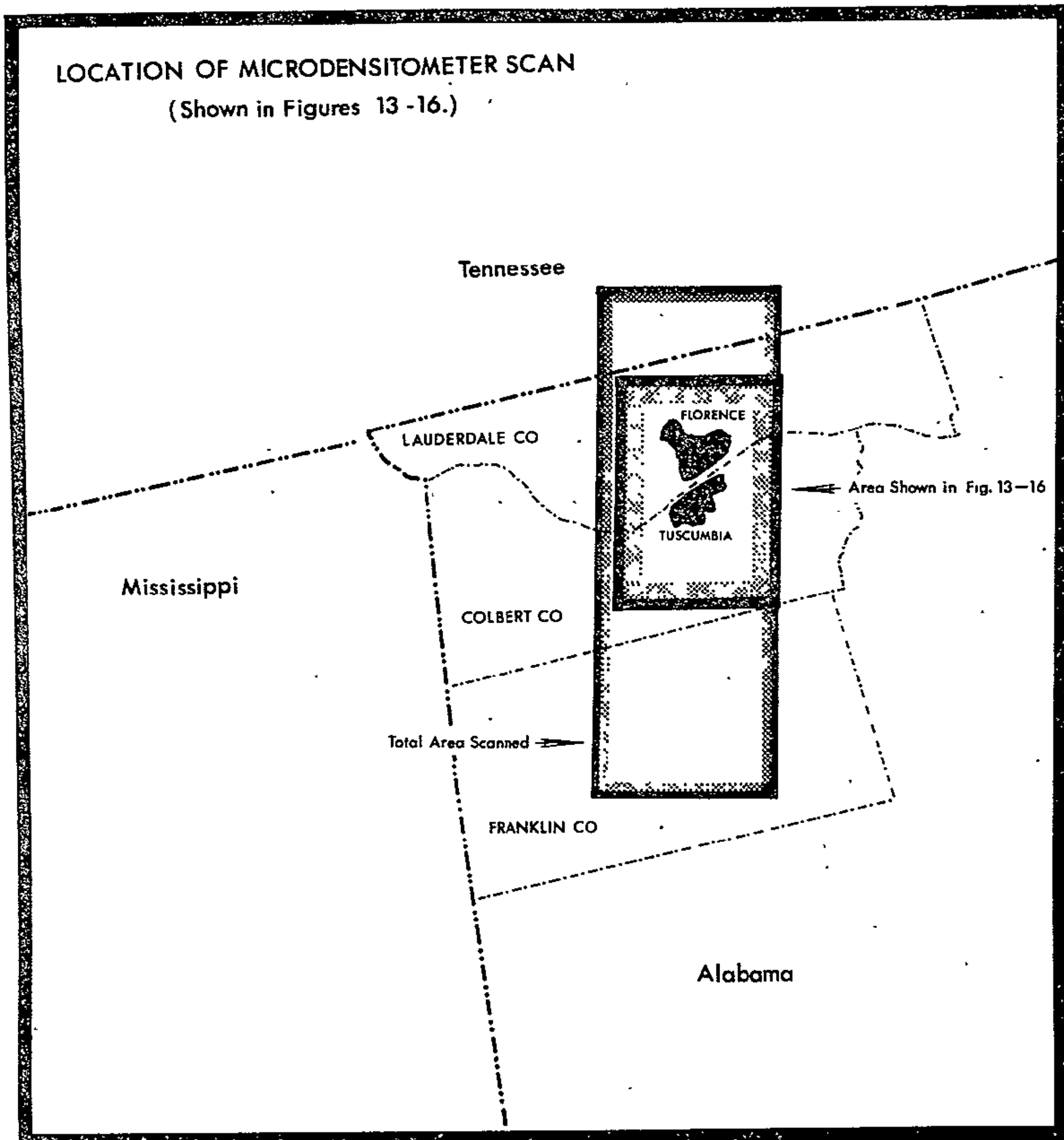

LOCATION OF MICRODENSITOMETER SCAN
(Shown in Figures 13 -16.)
Tennessee
LAUDERDALE CO
FLORENCE
TUSCUMBIA
Area Shown in Fig. 13—16
Mississippi
COLBERT CO
Total Area Scanned
FRANKLIN CO
Alabama

Figure 12.

detected by the microdensitometer. The microdensitometer is capable of recording density differences for 256 levels; thus the gray scales graduations were as follows: 0-24; 25-49; 50-74; ...; 225 to 256. The most intense reflections were recorded with the darkest-appearing symbol for each of the filter combinations.

A rigid research design was not constructed around the use of the microdensitometer for this experiment; the use of an arithmetic gray scale progression is indicative of this fact. No particular set of expected results was anticipated, but it was hoped that the use of the microdensitometer would verify the existence of boundary situations which separated the various photomorphic regions.

Preliminary Results of Automatic Interpretation Experiment.--The area of the Apollo 9 photography which was scanned was a north-south strip which included a portion of (1) the Tennessee Valley Small Farm region, (2) the Tennessee Valley Large Farm area, (3) the Tennessee River empoundments, (4) the Little Mountain Woodland area, (5) the Mountain Valley region, (6) the Upper Coastal Plain Farming region, (7) the Florence-Sheffield-Tuscumbia urban complex, and (8) the Russellville Mining section. A portion of the printouts of these are seen on Figures 12, 13, 14, 15, and 16. Each of the four gray-tone maps portrayed different landscape features at different levels of recognitions. The most easily distinguished patterns and the greatest amount of spatial information was displayed on the map which was the product of the red filter processing procedure; nevertheless, each filter printout reveals information of some kind. The signatures identified via the microdensitometer procedure were clearly of two types--point or area signatures. Although line signatures (such as roads, railroads, and pipelines) sometimes are identifiable, they are more difficult to detect than either point or line signatures.

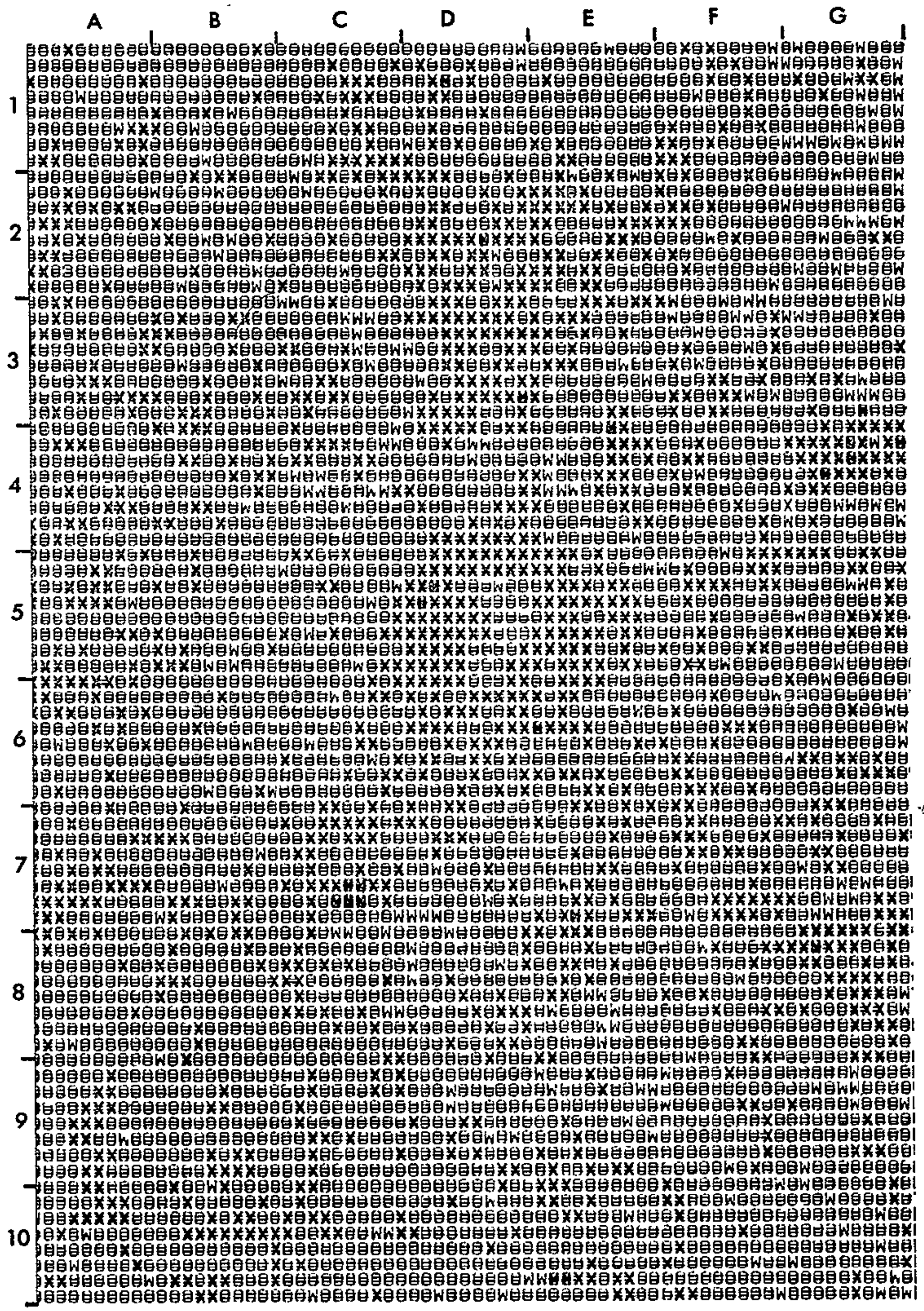


Figure 13
Pictorial gray tone map of microdensitometer scan with neutral density filter.

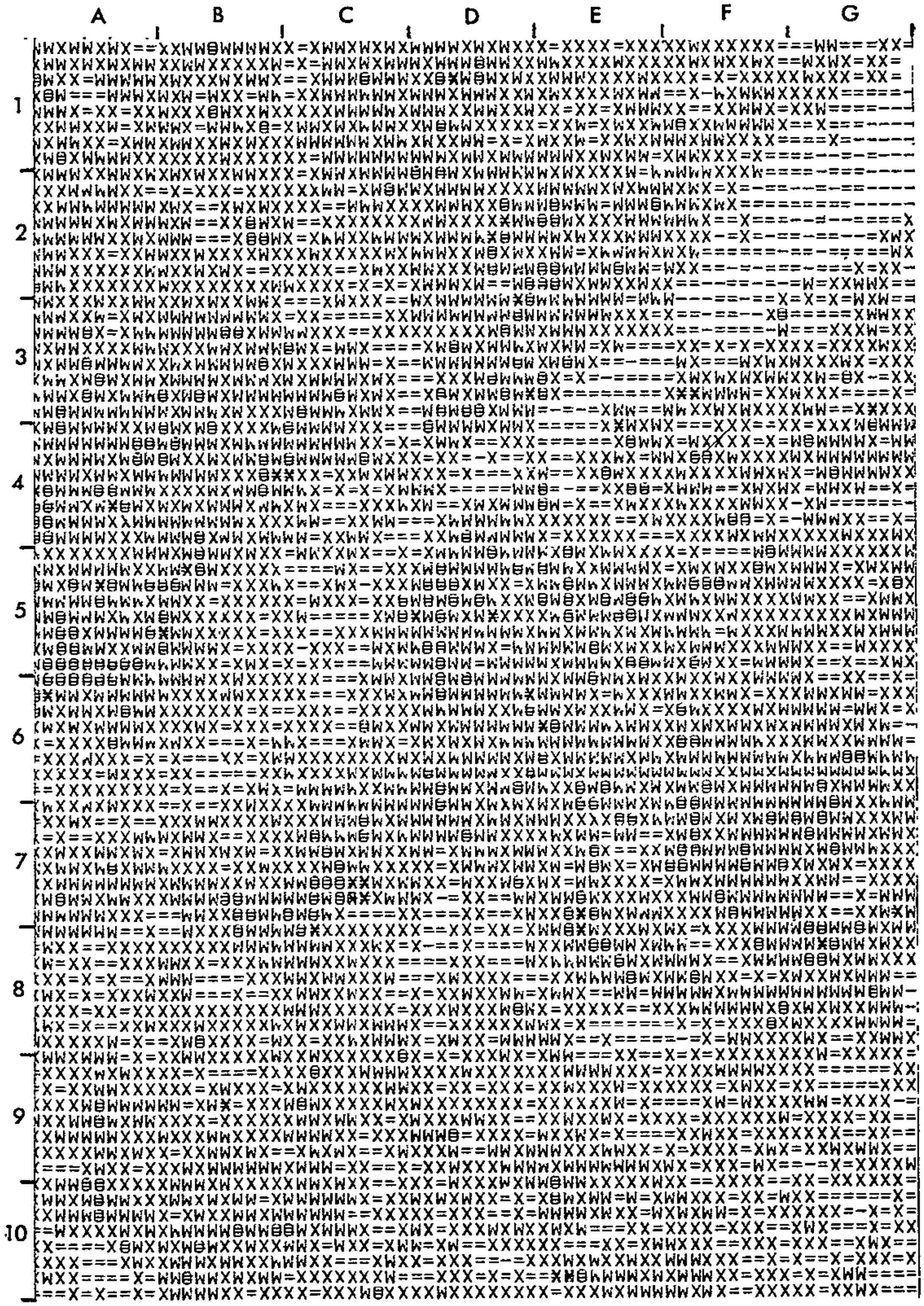


Figure 14
Pictorial gray tone map of microdensitometer scan with Red-Wratten No. 92 filter.

2

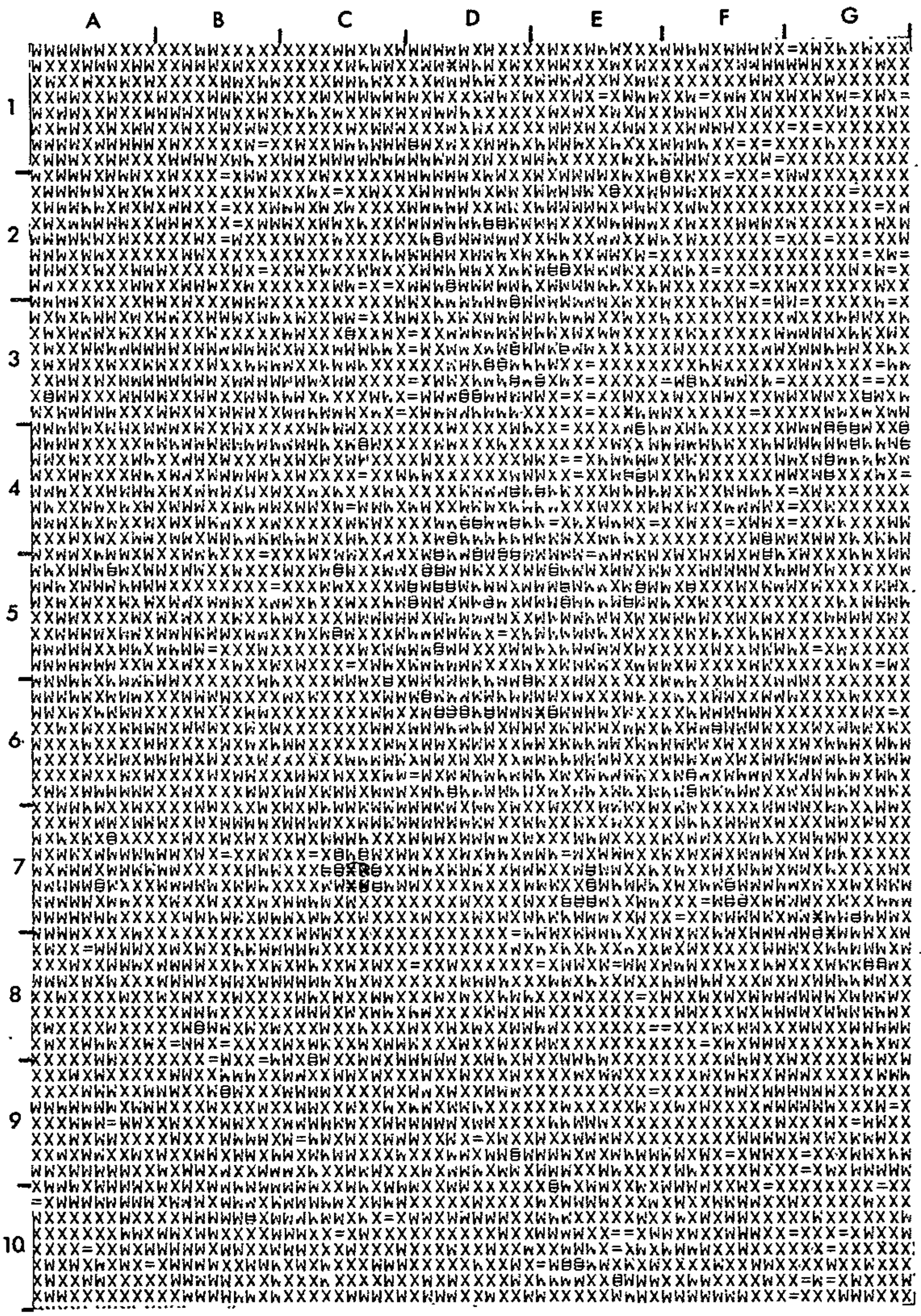


Figure 15
Pictorial gray tone map of microdensitometer scan with Green-Wratten No. 93 filter.

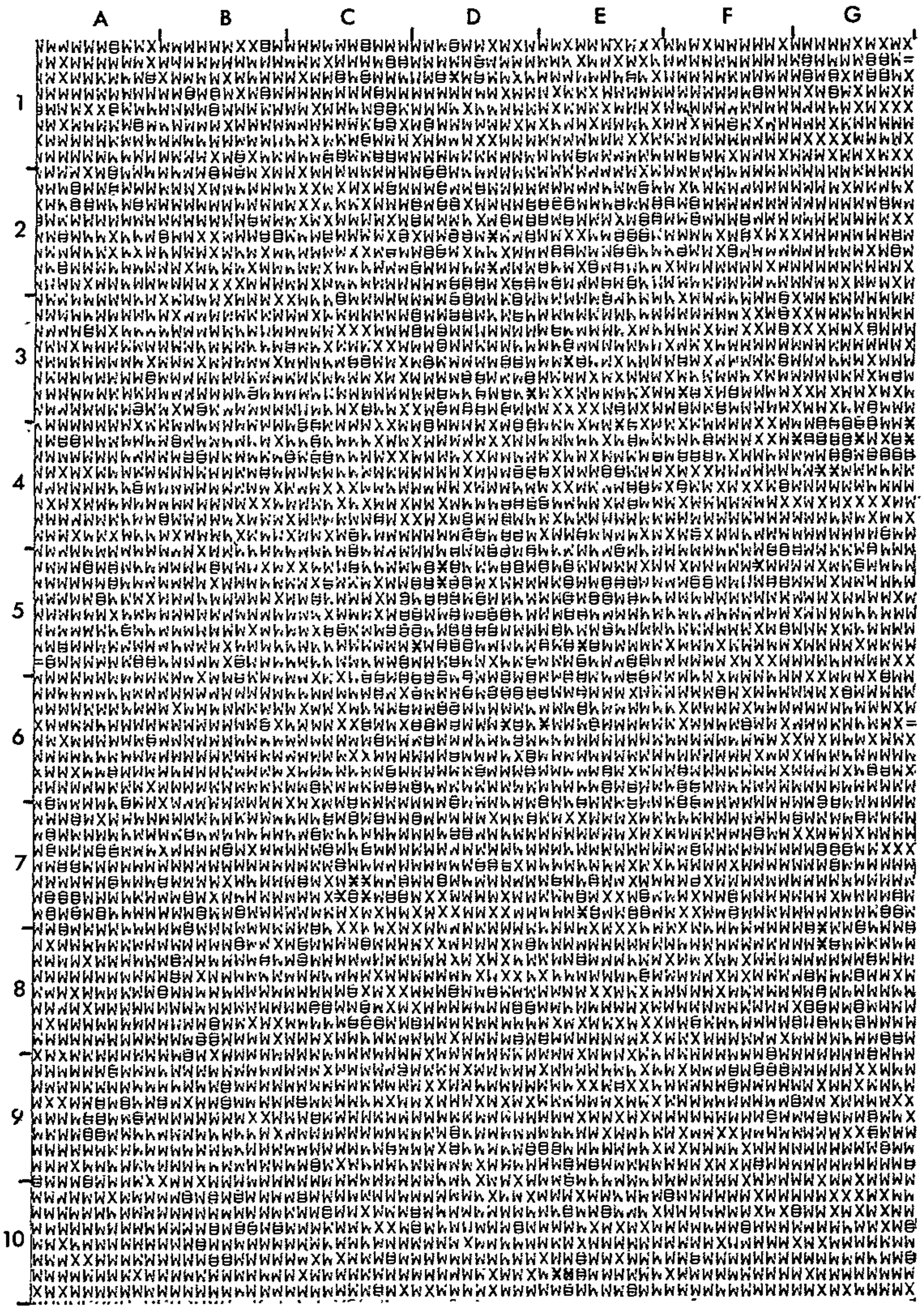


Figure 16

Pictorial gray tone map of microdensitometer scan with Blue-Wratten No. 94 filter.

The map density display using the red filter clearly delineates large water bodies, the Tennessee River, and its associated reservoirs (shown on Figure 14 in the area extending from G-1 and 2 diagonally across the map to A-7; with either (-) or (=) symbols). The same symbol printout also represents riparian and pine-mixed deciduous forest communities. The riparian vegetative communities extend away from the large water bodies; thus, it is difficult, if not impossible, to differentiate these communities from tributory water bodies, bays, and coves of the waterway. On the other hand, the pine-mixed deciduous forest communities are spatially separated from the large reservoirs, and can be distinguished in terms of their locations and geometric configurations (located in the lower section of the map).

It is noteworthy that a signature for the Florence-Sheffield-Tuscumbia urban complex can be recognized only on the neutral density printout (See Figure 13). The urban built-up region forms a continuous pattern of (Ж) symbols between grid values D and E and 2 and 6. The same symbol also represents grassland areas--pastures and idle land. And grassland areas can be differentiated from the large urban complex of Florence-Sheffield in terms of their location and frequency of occurance, i.e. they are displayed as individual signatures, in general. A problem, however, arises with respect to differentiating small central places from large blocks of pasture/idle lands existing in close proximity (such as at G-8 on Figure 13). The map printout symbol for both such phenomena is the same. It is noteworthy, however, that each central place of significant size (larger than village size)[27] has contained within its boundaries a symbol representing a more intense reflection (Ħ); open grassland pasture areas do not show these.

[27] Brian J. L. Berry and Allen Pred, Central Place Studies, A Bibliography of Theory and Applications (Philadelphia: Regional Science Research Institute, 1965) p. 6.

This same symbol, however, also represents clouds, an example for which is located at C-7 on the neutral density printout (See Figure 13). But because of the high reflective return off cloud cover, this feature can be recognized on all of the printouts.

Except for the heretofore mentioned urban area and the Russellville Mining region, none of the photomorphic regions representing rural landscapes were recognized per se from any one of the microdensitometer printouts.[28] It was, however, apparent that if the various printouts are contrasted against each other and known non-photomorphic signatures eliminated from the analysis--such as the reservoirs and the urban area--the photomorphic regions can be delimited. For example, the boundary between the Little Mountain Woodland and the Tennessee Valley Large Farm regions is detectable in terms of the differences of assemblages of signature symbols surrounding control points representing control areas. Both regions reflect the same types of signature display, but the Little Mountain Woodland area displays a higher percentage of (=) symbols and a greater variety of symbols than does the other region, especially on the red filter printout (See lower portions of Figure 14, between C-8 and G-8, and between C-8 and C-10). The concept, here, is that photomorphic regions can be identified in terms of their assemblages of different densities, quantities, and patterns; thus, the proportions of these different densities within a specified area can be determined.

One technique which can be used to note the assemblage of signatures that characterize an area is to place a circular mask over the printout. The circle represents a control area and the center of the circle is the control point for the area. The proportion of types of signatures that occur within

[28]The Russellville Mining area (See Figures 5 and 10) is not displayed on printout figures included in this report, but it was easily recognized on the red and neutral density printout of the total area scanned.

the area are represented by the control point, and significant boundary changes in the proportion types can be delineated by connecting points which represent the transition from one region to another. To test this procedure, the investigators "hand-counted" the assemblage and frequency of types;[29] this procedure, however, can be carried through using the computer and the original microdensitometer tape. This approach has the advantage of allowing the data to be statistically manipulated, especially for the purposes of classifying the control area cells.

It is significant that a high density return is obtainable on all four readouts for clouds. The signature for clouds apparently is the only signature which is distinctly displayed on the four printouts. It is, therefore, suggested that these printout signatures, if they are not too large, can be eliminated, and replaced by signatures which exist in the vicinity of the cloud area. This suggested technique should be highly valuable in creating a general statistical landscape situation which should not be too far removed from the actual situation. It is reasonable to assume that photomorphic traits around cloud signatures are similar to (if not the same as) the photomorphic traits located under the cloud, if the cloud cover density is not too large. While it is clear that clouds can be removed from the analysis and be replaced by other signatures, it is not known what the best statistical procedure would be to carry out such a task. It seems that random "gathering" technique would be most fruitful, e.g. if twenty-five cloud data symbols are removed, these would be replaced with data symbols from the vicinity of the

[29]It is freely admitted that the suggested technique described above is crude and needs to be refined. Particularly, research needs to focus on the method of obtaining an optimum size control area (or control areas) and the method whereby the variances among the proportion of types can be analyzed to determine to which areal category the control area belongs.

cloud, but randomly chosen. The exception to such a situation should be any definite lineal signals which trace through or from the cloud. These should be maintained in the same orientation and in the same proportions.

Conclusions

Although the results obtained from the analysis of a space photograph are not a panacea for all of the problems associated with geographical and planning research, there are benefits accrued from remote sensing systems which are unavailable through conventional data-acquisition systems. The investigation and analysis of the spacecraft image of northern Alabama has provided ample and substansive evidence that information for planning purposes can be gained through the use of techniques described in this report. The unique advantage of spacecraft imagery is the small-scale vantage point it provides to witness landscape characteristics over a large area. To be sure, the planners for any minor unit will be cognizant of local processes and events in their region of concern. For example, at any one moment of time, the planner for Florence, Alabama, will know what processes are at work in the area of the urban-rural fringe of that city; therefore, he is not in need of data from a spacecraft to resolve questions directed at this problem, or most other problems within his province of concerns. On the other hand, the state of the rural-urban fringe of <u>all</u> cities within an area as large as, say the State of Alabama, the Tennessee Valley, or the southeastern United States region,could be of great importance to planners responsible for these areas. These types of data have not been heretofore available as they are presented on a spacecraft photo, such as that of the Apollo 9 photograph of northern Alabama. Each change in scale or resolution will bring about new and different vantage points for viewing the assemblages of phenomena which characterize areas, and "...there is no basis for assuming

that associations existing at one scale will also exist at another."[30]

It appears that the inherent advantage of spacecraft imagery over conventional sources of data rests on its ability to portray a large segment of the earth's surface. The photomorphic region concept is intimately tied to this ability, for it is necessary to have the small-scale and large area overview before any meaningful results can be obtained. But morphological descriptions of landscapes alone are not significant unless they can be connected to behavioral and functional traits of the same. This process usually involves two steps. The first is to understand the factors responsible for the spectral and spatial component parts of the photomorphic regions. The second step is to understand the meaningful and surrogate relationships that exist between signatures on the space photography and the functional and nonvisual traits of the photomorphic regions; for example, the texture and tone qualities of the photography and population densities. The former step requires the use of conventional sources of data, such as large-scale air photograph (1/20,000 type), field investigations, and the Census. And it involves visualizing the link between the detail patterns of landscape within the context of the small-scale overview. Within the "scale linkage" process, quantitative solutions can be attempted.[31]

The second step is more difficult. It involves to a considerable degree, "value judgments" on the part of the investigator, and especially in terms of establishing significant geographical surrogate linkages between spectral and spatial traits of signatures and behavior patterns associated with landscapes. There is some evidence that similar morphological patterns may not be indicative of similar functional characteristics. Therefore, the

[30]Haggett, op.cit., p. 170.

[31]Ibid., p. 172.

analysis and interpretation of morphological patterns and their corresponding surrogate relationships should proceed through the use of the inductive approach. Each photomorphic region should be treated as a unique spatial entity, at least at this stage of the development of the concept. Furthermore, it is the opinion of the investigators that photomorphic regions, as derived from spacecraft imagery, are not only spatially and environmentally modulated, but they are also conditioned in terms of temporal situations. That is, seasonal variations of landscape characteristics may result in the combining (or separating) regions. It is suspected, however, that best photography for photomorphic region analysis (in the middle latitudes) is that which is taken in the early spring or fall. Summer photography will tend to be "clouded" by vegetative growth and winter photos may display snow landscapes. Nevertheless, seasonal photography should provide an avenue to the terrestrial processes associated with the march of seasons as well as being clue to developmental trends which are in progress.

John Friedmann, in his article on the "Concept of a Planning Region--The Evolution of an Idea in the United States" states that:

> City planners have been concerned mainly with creating a more efficient physical environment; regional planners have been principally engaged in solving problems of resources and economic development. The reason for this divergence is shown to lie chiefly in the controls available to urban, state, and federal governments for the implementation of policy objectives.[32]

To some degree the defining of controls by American governmental agencies for the purposes of implementing policy objectives is a result of American political processes and structures. But equally significant to these characteristic phenomena of planning practices in the United States is the fact that "...it

[32]John Friedmann, "The Concept of a Planning Region--The Evolution of an idea in the United States," in Regional Development and Planning, ed. John Friedmann (Cambridge, Mass: The M.I.T. Press, 1964) p. 497.

is congenial to the American pragmatic temperament..."[33] at least in terms of the "demands" by the public for rationality in the decision-making processes.

Decision-making processes improve, concomitantly, with progress toward better information systems. And the development of techniques of viewing the earth from space represents a "quantum jump" in the development of a methodology whereby information concerning the spatial attributes of physical, economic, and social phenomena can be integrated and analyzed for large and extensive areas of the surface of the earth.

[33] Ibid.

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